TRANSACTIONS

OF

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND

WITH

AN ABSTRACT OF THE PROCEEDINGS AT BOARD AND GENERAL MEETINGS, AND THE PREMIUMS OFFERED BY THE SOCIETY IN 1917

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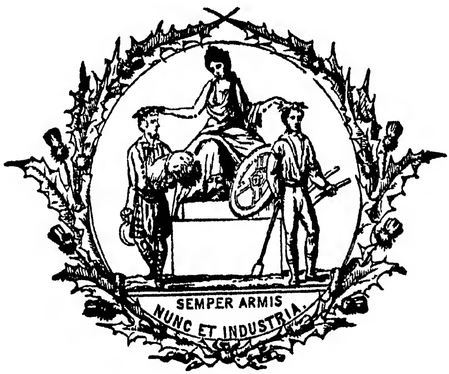

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CONTENTS

APPENDIX.

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ILLUSTRATIONS

TRANSACTIONS

OF

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND

THE GROWTH OF INTERNATIONAL TRADE IN MANURES AND FOODS.

By Professor JAMES HENDRICK, B.Sc., F.I.C., University of Aberdeen.

There are few people who realise how great is the international trade in manures and materials which go to make manures, and what enormous strides it has made during the past few years. Many know that there is an immense volume of trade in foods, which employs millions of tons of shipping; and we have all been brought during the past few months, under the perils of the world war, to realise the vital importance of this trade to the United Kingdom. There are still many, however, who seem to think that we have depended since time immemorial on overseas sources for our food supplies, and who neither understand the extent to which this trade has developed since the last great world war was fought, just over a century ago, nor how unprecedented are the present conditions of food supply, especially in this country, nor how greatly these new conditions have modified our military position and security. The present enormous volume of international commerce in manures and foods is practically a growth of the last century, and mainly of the last fifty years.

It is the intention to deal in this paper especially with the trade in manures; but manures and foods have been taken together since they are very closely interrelated, and even, to

a certain extent, interchangeable. When the farmer applies manures to the soil, he does so to increase his crops—that is, to increase the quantity of food raised from his soil. Therefore, if we import manures, we do so to increase the volume of food produced in the country; and by importing manure we increase the national supply of food and render it unnecessary—other things being equal—to import so much food. Also, the weight of fertilising material is not nearly so great as the increased weight of food which is raised by its aid; and thus by importing fertilising materials, up to a certain point we save shipping, for a far smaller tonnage will carry the manures than would be necessary to carry a weight of food equivalent to the increase which we expect to obtain by the use of the manures.

Conversely, when we import foodstuffs, we are importing manurial material, for every foodstuff has a certain manurial value, and when imported from abroad it brings to our shores manurial constituents drawn from the soil of the country where it was grown. No doubt much of this imported foodstuff is consumed in towns, and its manurial value is squandered down our sewers into the sea; but certain parts—such as the offals derived from the milling of cereals, and the oil-cakes obtained from the crushing of oil-seeds—are used to feed stock, and the manurial value is, or should be, largely recovered in the dung of the farm. Hence farms which consume much imported foodstuff should not require to consume so much imported manure.

For many years we have been, in a general way, conscious of the importance of our overseas commerce in foodstuffs, and of the danger which would arise in case of war if our importation of foodstuffs should be interfered with; but neither our statesmen nor the people, except in the case of a few exceptional individuals, had knowledge, foresight, and imagination enough to realise adequately the position, or to take in advance the measures which might have been taken to provide safeguards against the dangers which have now arisen. This lack of foresight and technical knowledge has been shown not merely in regard to the direct supply of foodstuffs from abroad, but in the failure to safeguard the supply of manures by which the produce of our land at home is maintained, and to foster and promote the increased use of manures by which the produce of our soil is increased. For instance, to take only two examples, the outbreak of war found us almost entirely dependent on Germany for potash manures, and little or nothing had been done in the past to explore and develop home sources of potash compounds; and in recent years industries have been developed in other countries for the preparation of synthetic nitrogen compounds,

the world-wide importance of which has, in nearly all great industrial and agricultural countries except Britain, attracted the intense attention of statesmen and capitalists. Here these new industries have merely been smiled at as the play of theorists and men of science.

MANURES.

Early History.—There has always, since international commerce existed at all, been international trade in foodstuffs, and, especially in earlier times, in the more expensive and less essential foodstuffs, but international commerce in fertilisers may be said to have originated about 1840. Before that date the bulky and locally produced dung and lime were almost the only fertilisers. A certain amount of trade in bones existed before that date, and there was probably a small amount of trade in other refuse materials of animal origin and in oil-cakes which were used as manure. By 1840 agricultural chemistry had made considerable progress. Much had already been learned as to the requirements of plants and as to the sources from which they derived the constituents which they needed. The time was ripe for practical applications of the knowledge which had been gained, and the necessary scientific stimulus was given by the great German chemist Liebig, who propounded his theory of manuring, which attracted much attention and led to much discussion and experiment. At the same time, the introduction of Peruvian guano supplied a concentrated manure of a unique kind which more readily attracted the attention of practical agriculturists than purely chemical substances like superphosphate and ammonia salts, which began to be used about the same time.

Guano is said to have been used in Peru as a fertiliser before Europeans discovered America. It was first brought to Europe about 1804 by the famous traveller Humboldt,[1] but it was not till 1839 that it began to be imported in bulk. Its use was a revelation to people who had been accustomed only to bulky manures like dung, or to slow-acting manures like bones. There is no manure on the market at the present day of such all-round excellence as the Peruvian guano, which was obtained from the Chincha islands, and contained about 14 per cent of nitrogen, together with 20 per cent or more of phosphates and a little potash. It contained these constituents in a highly available state, much of the nitrogen, phosphate, and potash being water

[1] Sir Humphry Davy in his 'Elements of Agricultural Chemistry,' 1813, mentions guano as "the manure that fertilises the sterile plains of Peru," and states that he had tried experiments with some specimens sent to the Board of Agriculture in 1805.

soluble, and the remainder in readily available forms. It was also in its favour, in the estimation of ordinary farmers, that it was a natural manurial material derived mainly from the dung of sea-birds. Birds' dung has been held in high regard since time immemorial as a fertiliser, and the fact that this wonderful new manure was composed of birds' dung, and had a strong manurial smell, undoubtedly helped it to come rapidly into favour among farmers. Be that as it may, no concentrated manure ever sprang more rapidly into extensive use than guano,[1] and that with a generation quite unfamiliar with concentrated manure. Its introduction did more to accustom farmers to the idea of concentrated fertilisers and their use than anything else could have done. Naturally, it met with opposition and ridicule, but still people tried it, and probably no amount of writing and teaching could have so rapidly taught the agricultural public a great new lesson in the use of manures as did the placing of guano on the market. Its opportune introduction probably did more to advance the use of concentrated manures throughout the country than all the work of the early experimenters and all the writings of the agricultural scientists of the period.

It is difficult to get accurate figures of the production and consumption of fertilisers in the early period of the industry, and in the case of many manures it is not till after 1880, or even after 1900, that any complete statistics are available. Before that time the main deposits of Peruvian guano were worked out. It is said that so rapidly did the use of guano increase that by 1855 over 400,000 tons per annum were exported from South America, of which about 200,000 tons were used in the United Kingdom. Some estimates place the consumption in the United Kingdom much higher. During the height of the Peruvian guano trade the export reached about half a million tons per annum, but as the deposits were limited, they soon began to be worked out, and after 1870 the industry began to decline. Even in 1855, Dr T. H. Way, chemist to the Royal Agricultural Society,[2] stated: "Although importations of guano are enormous, the supply is not always equal to the demand." It is interesting to note, however, that according to the prices he gives for manures in that year, guano was much cheaper per unit of nitrogen than either nitrate of soda or sulphate of ammonia, and much cheaper per unit of phosphate than bones, ground coprolites, or superphosphate. Though

[1] John Shier, in his edition of Davy's 'Elements of Agricultural Chemistry,' published in 1844, gives a long account of guano, which, he states, "within the last few years has been largely imported into Britain, and . . . it is generally esteemed the most valuable of extraneous manures."

[2] Jour. Roy. Ag. Socy., xvi. 540. 1856.

other parts of the world were ransacked for guano, and deposits were worked in many places other than Peru, the industry fell away to comparatively small proportions after 1880. The Peruvian guano industry was the first international manure industry which involved a great overseas commerce, and employed a large fleet of ships.

Meantime other manure industries, which were destined to reach even greater dimensions and to be more permanent, had been founded and were gradually extending. Of these, the most important was the dissolved phosphate industry. In 1836 Liebig suggested the dissolving of bones by acid in order to make them more available to plants. According to Smetham,[1] Messrs T. & H. Procter of Bristol entered into communication with Liebig and Boussingault, and began, before 1840, to place dissolved phosphates, made from bones, bone ash, and bone black, upon the market. Soon afterwards Lawes began to dissolve ground coprolites, and started at Deptford the first factory for the manufacture of mineral superphosphate. This new industry at first grew slowly, as it was quite eclipsed by the rapid rise of the guano industry; and it was not till the supplies of guano began to fail that the manufacture of mineral superphosphate increased to really great proportions, and that a world-wide trade in raw mineral phosphates for the manufacture of superphosphate arose.

It was about 1840 also that the use of ammonium salts as manure gradually arose, and about the same time nitrate of soda, which was already being imported into Europe from South America for other purposes, began to be tried as a fertiliser. The use of these increased slowly during the period when guano was the supreme concentrated manure.

This early period in the use of artificial manures extended from about 1840 to about 1880, and during it, though much experimental and scientific work was carried out on the Continent, Britain was the great home of the manure industry, and was the pioneer and most extensive user of artificial manures. During this period our knowledge of the requirements of plants and of the effects of manures was greatly extended,—in Britain by the work of the Rothamsted Experiment Station, founded and carried on by Sir John Lawes, and by the experimental work carried on under the auspices of the great Agricultural Societies and by many private individuals; and on the Continent by the many Agricultural Research Stations and Agricultural teaching institutions which had arisen mainly with State support. During this period Britain was also supreme in the practice of agriculture, and was looked up to

[1] Jour. Socy. Chem. Ind., xvii. 980. 1898.

by other countries, not as at present merely as the great breeding-place for pure-bred stock, but as the leading exponent of good arable farming.

While it is difficult to get any accurate statistics of the increase in production per acre which took place about the middle of the nineteenth century owing to the use of guano and other concentrated manures, evidence is given in the writings of the period that such increases, which have been estimated at 50 per cent, did take place. Thus the distinguished agriculturist and President of the Royal Agricultural Society of England, Philip Pusey, in his last published paper,[1] gives the following quotation from a Norfolk corn-dealer's circular: "The yield of wheat has gradually increased during the past four years, mainly through the use of artificial manures used as top-dressings, that it is difficult to define what is an average crop"; but Pusey himself adds, "Over the greater part of England no one would say that this practice, even if known, has become an ordinary act of husbandry." He then goes on to make the statement that if our "French neighbours and friends" would adopt the practice, it would be an "easy method of preventing deficient crops from which France has lately suffered." This seems to indicate not only that an increase of crop might be obtained by the use of artificial manures, but that these were not used in France as they were, in parts at any rate, of Britain.

From the beginning of the nineteenth century Britain was looked up to by Germany and other Continental countries as the home of good arable farming, and probably no part of Britain had a greater reputation in this respect than the South-East of Scotland. After the introduction of artificial manures crop production seems to have increased considerably in those parts of the country where these manures were used, and for all the period from the beginning of the century up till, at any rate, 1880 we retained a high reputation for production per acre of all the leading crops we grew.

After 1880 the great period of agricultural depression set in, and arable farming began to decline in Britain. It is not the purpose of this paper to deal with the decline of agriculture in Britain and its causes, but the result has been that, in the modern period between 1880 and the present day, when the fertiliser industry rapidly grew to a great world industry, employing immense numbers of people in the mining, manufacturing, and transport of fertilising materials, Britain has only developed slowly as a manufacturer and user of artificial manures, and has been overtaken and passed by other countries, till now we occupy a quite secondary place in the world's fertiliser

[1] Jour. Roy. Ag. Socy., xvi. 582-3. 1856.

markets, in which at one time we were supreme. The enormous increases which have taken place in the production, transport, and consumption of fertilisers have been due almost entirely to the rapid advance of other countries, and this, as will be shown later, has reacted on our crop-producing capacity as compared with others. It is not so much that we have gone back, as that others have gone forward rapidly, while we have relatively stood still and allowed them to pass us. Several countries which started much behind us have now caught up and passed us as manufacturers, importers, and users of fertilisers, and, consequently, as producers of crops.

We may next take in order the leading artificial manures, and trace the growth in their production and use, so as to bring out how rapidly the fertiliser industry has been developing, especially since the beginning of the twentieth century. As has been already pointed out, the industry increased only gradually, except in the case of Peruvian guano, till after 1880, and was chiefly a British industry. After 1880 other countries rapidly came to the front as users of fertilisers,—first, the leading countries of Western Europe, Germany, France, Belgium, Holland, &c., in which there were well-developed systems of agricultural education and research, began to reap the fruit of the systematic training of their people in agricultural science, which, along with other factors, led to a very rapid increase in the consumption of fertilisers; second, new countries like the United States, which had paid little attention to fertilisers so long as they had plenty of virgin soil to break up, began to pay attention to this subject, and have rapidly become great manufacturers and users of artificial manures; and third, ancient Eastern countries like Japan and India have become important markets for fertilisers.

In recent years it has become easy to obtain statistics of the international use and production of manures, since the International Institute of Agriculture, Rome, collects and publishes such figures. These are to be found in the half-yearly reports on "The International Movement of Fertilisers," published in the September and March numbers of the 'Monthly Bulletin of Agricultural Intelligence and Plant Diseases,' issued by the Institute, and in the 'Annuaire International de Statistique Agricole,' issued by the Service de la Statistique General of the Institute. The Bureau of Agricultural Intelligence and Plant Diseases of the Institute, also issued in 1913 a pamphlet entitled 'Production et Consommation des Engrais Chemiques dans le Monde.' All these publications have been drawn upon for the statistics which follow.

The admirable statistics issued by the International Institute, however, take us back, as a rule, only to 1903 or 1905. The

Institute was itself established under International treaty in 1905. If earlier information is wanted, it has to be collected, with much trouble, from a great many sources, both official and unofficial. Many such sources have been drawn upon for what follows. The further one goes back the more difficult it is, as a rule, to get reliable figures. Great Britain also has not distinguished itself in the past, in comparison with some other countries, for the laborious and accurate compilation of industrial statistics, though a great improvement has been effected in recent times.

The three great classes of artificial manures—nitrogenous, phosphatic, and potassic—will be taken in turn.

Nitrogenous Manures.

When the use of concentrated nitrogenous manures began about 1840, nitrate of soda was already being imported from South America. Early trials showed its great value, and though it did not impress the popular imagination like guano, it came steadily and increasingly into use. The following table, prepared from figures kindly supplied by the Chilian Nitrate Committee, gives the average annual export from South America for five-yearly periods from the start of the industry to the present day. The official figures are given in Spanish quintals, and have been converted into tons (22 Spanish quintals equal to 1 ton).

TABLE I.

NITRATE OF SODA.

Average Export from Chili for Five-Yearly Periods

Year.	Tons.
1830-1834	3,201
1835-1839	6,759
1840-1844	14,684
1845-1849	18,770
1850-1854	29,641
1855-1859	51,259
1860-1864	72,667
1865-1869	105,400
1870-1874	207,519
1875-1879	243,069
1880-1884	332,828
1885-1889	667,145
1890-1894	929,255
1895-1899	1,206,300
1900-1904	1,340,636
1905-1909	1,821,845
1910-1914	2,344,627
1915	1,999,272
1916	2,914,909

It will be seen that there is an increase in export each five-yearly period. At first the increase is comparatively slow, and it is not till the period 1865-69 that the average export passes 100,000 tons. Then the increase is somewhat more rapid till after 1880, when once more the pace increases, and continues very rapid till the present day.

Up to 1870 the United Kingdom was the great consumer of nitrate of soda, and took far more than all other countries put together. The Chilian Nitrate Committee was formed in 1889, and it has not been found possible to obtain any complete statistics of the world's deliveries for consumption of nitrate of soda before that date. In 1873, 124,000 tons of nitrate were imported into the United Kingdom, and the total export from Chili was 284,717 tons, which was much over the average for the ten years from 1870 to 1879. In other words, at this period the United Kingdom still took about half of the total nitrate exported from South America. The great expansion in consumption which has taken place is shown in the next table, in which "deliveries for consumption" is shown at intervals of five years, from statistics supplied by the Chilian Nitrate Committee.

TABLE II.

NITRATE OF SODA.

DELIVERIES FOR CONSUMPTION

Year.	Tons.
1889	734,860
1894	987,550
1899	1,344,550
1904	1,429,150
1909	1,922,000
1913	2,464,540
1914	2,181,646
1915	1,731,910

The greatest consumer of nitrate is now Germany, though the United States has been coming up rapidly during recent years; but probably the greatest consumer per arable acre before the war was Belgium, which little country consumed more than the whole of the United Kingdom. The following Table, III., shows the approximate consumption (import less export) of nitrate by certain countries for the years 1905 and 1913, and is derived from the statistics of the International Institute of Agriculture.

TABLE III.

NITRATE OF SODA.

Consumption in Different Countries. (Import less Export.)

	1905. Metric tons.	1913. Metric tons.
United Kingdom	99,311	143,187
Belgium	143,426	164,145
France	226,753	316,847
Germany	520,386	746,791
Italy	46,093	67,368
Holland	37,238	82,490
United States	326,386	635,905

The above statistics show that the United Kingdom was already consuming about 100,000 tons of nitrate in the seventies, and Table III. shows that this rate of consumption had not been seriously increased right up to the eve of the outbreak of the present war. On the other hand, Continental countries, and especially Belgium, France, and Germany, have increased their consumption at a very rapid rate, as has also the United States.

For a long period the only serious rival of nitrate of soda as a concentrated nitrogenous manure was sulphate of ammonia. Ammonia compounds were experimented with as fertilisers early in the nineteenth century. A small supply of these salts was already being produced before 1840 from the ammoniacal liquor of gas-works, and ammoniacal liquor itself had been tried as a manure. About 1840 sulphate of ammonia had not yet established its position as the standard form in which ammoniacal salt was to be used for agriculture. Thus we find that in the Rothamsted experiments both sulphate and muriate of ammonia were used. In other early experiments carbonate of ammonia was also tried. After a time, however, it was found that the sulphate was the most cheaply and readily prepared salt of ammonia, and it has for a long period now been practically the only salt of ammonia used as manure.

For many years after 1840 the production of ammonium salts was small, and little was used for agricultural purposes. Up to 1880, or even 1890, the manufacture of sulphate of ammonia appears to have taken place mainly in Britain, in which country also most of it appears to have been consumed. Since 1880 the growth of the industry has been rapid, and Germany and the United States have become large producers, while many other countries, notably France, Belgium, and Austria-Hungary, produce considerable quantities. Table IV. shows the production of the chief producing countries—the

United Kingdom, Germany, and the United States—for every fifth year up to 1910, and yearly after that date. Most of these figures were kindly supplied by Messrs Bradbury & Hirsch, Liverpool, and by the Sulphate of Ammonia Committee, London, but some of the later figures are taken from statistics published by the International Institute of Agriculture. (*N.B.*—All figures quoted from the returns of the International Institute are in metric tons of 1000 kilos, equal to 2205 lb.)

TABLE IV.

PRODUCTION OF SULPHATE OF AMMONIA.

	United Kingdom.	Germany.	United States.
	Tons.	Tons.	Tons.
1870 . . .	40,000	...	...
1875 . . .	46,000	...	...
1880 . . .	60,000	...	...
1885 . . .	97,000	...	...
1890 . . .	134,250	...	...
1895 . . .	171,000	About 50,000	...
1900 . . .	213,000	130,000	24,600
1905 . . .	268,500	190,000	69,250
1910 . . .	367,500	373,000	105,140
1911 . . .	385,000	418,000	115,245
1912 . . .	388,000	492,000	149,700
1913 . . .	432,000	549,000	176,900
1914 . . .	426,000	...	166,010
1915 . . .	426,000	...	220,000
1916 . . .	438,000	...	...

It is to be remembered that all these figures are more or less accurate estimates, and that figures published by different authorities differ slightly from one another.

'The Chemical World' for January 1912 stated the world's production of sulphate of ammonia as follows:—

	Tons.
1860	2,000
1900	450,000
1905	625,000
1910	1,100,000

The International Institute of Agriculture gave the world's production for 1913 as 1,412,032 metric tons.[1]

Germany overtook the United Kingdom as a producer of sulphate of ammonia in 1910, and just before the war had passed us by over 100,000 tons per annum. Since the out-

[1] Monthly Bulletin of Agricultural Intelligence and Plant Diseases, March 915, p. 332.

break of war there is every reason to believe that the production in Germany has been very greatly increased, mainly by the development of the Haber process for the synthetic production of ammonia from nitrogen obtained from the atmosphere. Reports which have reached this country, and which may not be very trustworthy, state that in 1916 Germany produced ammonia equivalent to nearly a million tons of sulphate of ammonia.

Before the war the United Kingdom was by far the greatest exporter of sulphate of ammonia. We exported practically three-fourths of what we produced, and imported none, therefore only about one-fourth of our production was used at home for all purposes. While the principal use was as a fertiliser, this was by no means the only use of sulphate of ammonia. From 1900 to 1914 the amount of sulphate of ammonia consumed in the United Kingdom for all purposes was estimated by Messrs Bradbury and Hirsch at from 65,000 to 97,000 tons per annum, while we exported to many countries, and especially, during recent years, to Japan, Spain, the United States, and Java.

On the other hand, other countries, and in particular Germany, consumed most of what they produced. At one time we exported a large amount of sulphate of ammonia annually to Germany, and as late as 1905 Germany imported more than she exported, and the same was true of that intensively manured and cultivated country, Belgium. It is estimated that in 1900 Germany consumed 126,000 tons, in 1910, 350,000 tons, and in 1913, 500,000 tons of sulphate of ammonia. The United States consumed the whole of what she produced, and was also a large importer from 1910 onwards; and Japan in recent years has been the greatest importer of all, importing in each of the years 1913 and 1914 over 100,000 tons, and, in addition, consuming the whole of the small supply produced at home. It is evident, then, that as in the case of nitrate of soda, so in the case of the still more concentrated nitrogenous manure sulphate of ammonia, we have been far surpassed as consumers by other countries.[1]

One of the most important developments in connection with nitrogenous manures during the twentieth century has been the development of the manufacture of synthetic nitrogenous manures from the nitrogen of the atmosphere. As the above statistics show, the world's consumption of concentrated nitro-

[1] In 1916, war conditions caused a large increase in the consumption of sulphate of ammonia in the United Kingdom, and it is probable that in 1917 the consumption will increase still further. It is estimated by Messrs Bradbury & Hirsch that the consumption in 1916 was 178,500 tons.

genous manures is increasing at a very rapid rate. Though the known supplies in the nitrate beds of Chili are very large, still, if the consumption goes on increasing at its present rate, they will be exhausted in a comparatively limited space of time. The estimates of the available supplies of nitrate of soda in these beds, and of the time which they will last, vary very greatly, but even the most optimistic estimates indicate that exhaustion will begin to be felt at no very remote period if the agriculture of the world is to continue to develop in the future as it has been doing during the past thirty years. No doubt the supplies of sulphate of ammonia obtained from coal, and produced synthetically, can be, and will be, greatly increased. Yet it is obvious that not only is it very necessary to look ahead and consider the requirements of the future, but that there is a great opportunity for the exploitation of new nitrogenous manures, and that the possibilities for the discoverers of workable commercial processes for preparing such manures are limitless. Consequently, many minds were applied to this problem in Britain, as well as in other countries, but with this difference, that in Britain only scientific work was done upon it, and in commercial and financial circles it attracted little or no serious attention. On the other hand, in countries such as Germany and America, not only were able scientific workers engaged upon the subject, but they were encouraged and supported by capitalists who had a sufficiently wide outlook to realise the world-wide commercial possibilities of a successful process. Several processes have now been devised, and are working on a large scale. To treat of these would require a separate paper, but already before the war two processes, at any rate, had become subjects for international commerce on a considerable scale. These are the Birkeland and Eyde process for the manufacture of nitrates, and in particular nitrate of lime, and the cyanamide process. In both of these processes the atmosphere, in which there are unlimited free supplies, is used as the source of nitrogen, and cheap supplies of electric energy, generally obtained from water power, are also made use of. The cyanamide manufacture is carried out in many countries, while the nitrate of lime process is practically confined at present to Norway. Calcium cyanamide, which is commonly known in this country as nitrolim, began to be produced in commercial quantities early in the present century in Germany and Italy. It is difficult to get accurate figures for the actual production, but Table V. gives figures for 1910 and 1913, taken from statistics published by the International Institute of Agriculture.[1]

[1] Annuaire Internationale de Statistique Agricole, 1913 et 1914, p. 679.

TABLE V.

PRODUCTION OF CALCIUM CYANAMIDE (NITROLIM).

(METRIC TONS.)

	1910.	1913.
Germany	11,500	24,000
Austria-Hungary	...	7,500
France	1,000	7,500
Italy	3,715	14,980
Norway	4,280	22,110
Sweden	...	18,350
Switzerland	...	7,500
United States and Canada	...	48,000
Japan	...	7,000
Total	20,495	156,940

This table shows the rapid increase in the number of producing countries and in the amount produced. None is produced in the United Kingdom, which obtains the small amount which it consumes from Norway.

The production of synthetic nitrate of lime was, before the war, confined to Norway, and the rapid increase in production is shown in Table VI.

TABLE VI.

PRODUCTION OF NITRATE OF LIME IN NORWAY.

(METRIC TONS.)

Year	1905	1906	1907	1908	1909	1910	1911	1912	1913
Metric tons	127	1181	1601	5102	11,953	18,569	13,152	36,468	73,214

Most of the nitrate of lime produced by Norway was, before the war, exported to Germany. Since the outbreak of war this has been a most valuable source of nitrate to that country, which normally imported such great quantities of nitrate of soda from Chili, and has been almost entirely deprived of that valuable material for more than two years. The nitrate industry in Norway also produces nitric acid and nitrate of ammonia, both substances most valuable and necessary to Germany for munition purposes, and this new source of supply must have been of incalculable value to our enemies during the present conflict. It is also understood that, since the outbreak of war, Germany has manufactured great quantities of synthetic nitrates and nitric acid in her own country for the supply of her munition factories and her agriculture. Our great enemy is being well repaid for the earnest attention her men of science and her

capitalists gave before the war to the development of synthetic processes for the manufacture of nitrogen compounds.

The International Institute of Agriculture does not give separate returns for the export and import of cyanamide and nitrate of lime, but classes all synthetic nitrogenous manures under one head in the statistics of export and import. There are few figures for import given till 1912, and the following Table (VII.) shows the imports in that year and 1913 for the chief importing countries:—

TABLE VII.

IMPORTS OF SYNTHETIC NITROGENOUS MANURES.

(METRIC TONS.)

	1912.	1913.
France	3,160	10,010
Germany	44,612	78,257
Russia	2,244	2,326
United States . . .	7,248	14,891

It will be seen that Germany was by far the most important importing country. Unfortunately statistics are not available since the outbreak of war.

Norway, on the other hand, is the chief exporting country for synthetic nitrogenous manures, as she exports most of what she produces. The exports of Norway during the past few years are given in Table VIII., which shows that the industry in synthetic nitrogenous compounds is rapidly becoming a very valuable one for Norway.

TABLE VIII.

EXPORTS OF SYNTHETIC NITROGENOUS MANURES FROM NORWAY.

(METRIC TONS.)

	1910.	1911.	1912.	1913.	1914.
Nitrate of lime . .	13,531	9,805	51,700	70,927	75,034
Nitrate of ammonia .	...	3,023	4,270	9,107	11,941
Cyanamide. . . .	4,281	13,182	13,892	22,111	14,688

Germany and Sweden are also considerable exporters of calcium cyanamide.

PHOSPHATIC MANURES.

Phosphatic manures are the most extensively used of all artificial fertilisers, and give rise to a greater volume of international commerce and to a more widespread manufacturing industry than any others. The earliest distinctively phosphatic manure used was bones, which contains a little nitrogen as well as its phosphate.

Bones were used to a certain extent as a fertiliser long before 1840, and there seems to have been in 1840 an industry in this country in bone manures almost as great as that which exists at the present day. John Shier, the first Fordyce Lecturer in the University of Aberdeen, states in an edition of Sir H. Davy's 'Elements of Agricultural Chemistry,' which he published in 1844, with additions and notes: "Bones have for many years been imported into this country from almost all the principal ports of the north of Europe, and for some time, though in less quantity, from the south of Europe, and even South America. Mr Neale's report on Agricultural Produce and Shipping in northern Europe, printed by order of the House of Commons in February 1842, furnishes some data from which an idea of the extent of the trade in this article may be obtained. Of eleven ports reported on, two were found to export none. Concerning Hamburg, which is known to export largely, no information could be obtained; but the remaining eight, namely, Rotterdam, Bremen, Kiel, Lubeck, Rostock, Stettin, Dantzic, and Elsinore, the total export amounted to 13,084 tons." He also states: "During the year, from 1st June 1840 to 1st June 1841, there were imported into Aberdeen from foreign ports 4355½ tons, and on an average of the last six years 3461 tons annually." Bones still continue to be a very popular manure in the Aberdeen neighbourhood. Statistics kindly supplied by the Harbour Treasurer show that during the ten years, 1907-1916, the average annual import of bones, bone ash, and bone meal through Aberdeen harbour was 7246 tons.

This interesting reference also shows that at that period we drew large quantities of bones from German ports, and presumably at that period German agriculture, which was in a very backward condition, did not use bones to any great extent as a fertiliser. It was about this period also that the famous German chemist Liebig accused England of rifling the battlefields of Europe and the catacombs of Sicily in her insatiate search for bones, which she "squanders down her sewers to the sea."

We probably still use bones as largely as ever, and many of our farmers have greater faith in them than in any other manure. All other manure-using countries also use bones, and no doubt so far as they can be obtained they are fully utilised for fertilising the soil. Though the import and export of bones make a respectable show in the world's trade returns, they are quite a small and secondary matter compared with such fertilisers as mineral phosphates, superphosphate, and basic slag, which are handled by the million tons, whereas in the case of bones the greatest figure which appears in the returns is a little over 100,000 tons for the export in certain

years from India. Bones are also largely exported from the Argentine and from Russia. The mean export from India for the five years, 1908-1912, was 87,376 tons per annum, and little was used in the country itself. Table IX. shows the exports for 1912 and 1913 from the chief exporting countries, and the imports into the chief consuming countries. The figures include not merely raw bones but treated bones, such as steamed bone flour and bone ash.

TABLE IX.

EXPORTS AND IMPORTS OF BONES AND BONE MANURES.

(Metric Tons.)

	Exports.		Imports.	
	1912.	1913.	1912.	1913.
British India	111,990	107,105	52	243
Argentine	31,878	31,611	...	...
China	29,976	33,682	...	...
Russia	43,228	39,723	668	2,527
Germany	36,795	33,125	53,185	55,326
Belgium	16,365	22,748	41,656	45,509
France	11,939	13,985	38,987	39,395
United Kingdom	...	...	41,862	41,336
United States	...	...	34,703	35,173
Japan	...	...	39,302	47,894

Belgium, France, and Germany are both importers and exporters, as they import large quantities of raw bones and export treated bones. In all the countries which use bones extensively large quantities of home bones are consumed in addition to the imported bones. In the United Kingdom it is estimated that the home bones amount to between 50,000 and 60,000 tons per annum. The total supply of bones of all kinds, including both raw and treated bones, available for use as manure, amounts therefore to about 100,000 tons per annum.

Great as are these quantities of bones, they are small in comparison with the mineral phosphates which are used in the preparation of fertilisers. As already stated, the use of mineral phosphates for the manufacture of superphosphate started soon after 1840. In the early years of the manufacture coprolites, obtained from Cambridge, Suffolk, and other English counties, were used. The production of coprolites in England attained considerable dimensions after the middle of last century, but fell away again to almost nothing during the last quarter of the century. No figures are known to the author for the years before 1874, but Mr G. Campbell Arnott, the Technical Adviser of the Fertiliser Manufacturers' Association, has kindly supplied

statistics of the output of phosphate of lime in the United Kingdom from that year onwards. These show that for the five years, 1874-78, the average annual production was 156,186 tons. It fell to 26,852 tons for the five years, 1884-88, and to 1950 tons for the five years, 1894-98. Since 1900 the production has been practically nil. Phosphorites, apatites, and phosphatic guanos also were imported from France, Spain, Germany, Belgium, and other parts of the world, and used for preparing dissolved manures during the early years of the industry. In recent times, however, the world's supply of raw phosphates has been drawn principally from two regions—the United States and North Africa—though important quantities have also been produced in France and Belgium and in certain islands in the Pacific Ocean, and small quantities in a number of other countries. Raw phosphates are found very widely distributed throughout the world, and there are few countries where some kind of phosphatic rock cannot be obtained. The industry has, however, in recent years concentrated in a few centres where great supplies are obtainable comparatively easily and cheaply, where transport is good so that the rock can readily be brought to the world's markets, and where the quality of the phosphate is such that it is suitable for the preparation of dissolved manures. English coprolites are no longer worked, because the supplies are limited and expensive to obtain, and because the material is of low quality from the manure manufacturer's point of view. On the other hand, Florida has become a great centre of the industry, because mineral of high quality is plentiful and easily mined, and can be readily transported to where it can be shipped all over the world. The production of raw phosphates by the principal producing countries for certain years from 1900 onwards is shown in Table X.

TABLE X.

PRODUCTION OF RAW PHOSPHATES.

(METRIC TONS).

	1900.	1903.	1905.	1910.	1912.	1913.
Belgium . . .	.	184,120	193,305	202,880	203,100	219,420
France . . .	...	475,783	476,720	333,506	330,000	335,000
United States .	1,491,216	.	1,964,210	2,724,849	3,231,636	3,202,636
Algiers . . .	about 300,000	320,834	334,784	319,079	388,515	461,030
Tunis	171,288	352,088	559,645	1,286,262	2,057,498	2,284,678
Egypt . . .	none	none	none	2,397	69,958	101,311
Christmas, Ocean, and Nauru Islands	...	...	211,052	456,000	459,512	...
All countries .	...	2,433,779	3,955,686	5,344,981	6,886,299	6,985,677

The figures from certain countries for 1912 and 1913 are not complete, as much delay takes place in certain cases in issuing statistics, so that the figures for the total production of the world for these years, and especially for 1913, require to be increased somewhat. The table is sufficient, however, to show the very rapid rate at which the world's production of raw phosphates is increasing. The United States, which has been for many years the largest producer of raw phosphates, embarked on this industry just fifty years ago—in 1867. An article by W. G. Phalen of the United States Geological Survey, published in the American Fertiliser Handbook for 1914, gives interesting statistics of the development of the industry from 1867 to 1912. From this publication the figures in Table XI. are taken.

TABLE XI.

PHOSPHATE ROCK PRODUCTION IN UNITED STATES OF AMERICA.

From 1867 to 1887 production was	4,412,945	tons.
1888	448,567	,,
1890	510,499	,,
1895	1,038,551	,,
1900	1,491,216	,,
1905	1,947,190	,,
1910	2,654,988	,,
1913	3,097,021	,,

The first United States' deposits to be worked were in South Carolina. It was not till 1888 that the Florida deposits began to be mined, but they soon became more important than those of Carolina. In 1896 production began in Tennessee, and this soon became of importance also. Practically all the American phosphates are obtained from these three States, over 80 per cent of the whole coming from Florida. There are also extensive deposits known to exist in several other States, such as Utah, Idaho, Wyoming, and Montana. The Bureau of Soils, U.S. Department of Agriculture, estimates that the reserves of natural phosphates in the United States, calculated as high grade material of 75 per cent tricalcic phosphate, amounts to 10,677,673,125 tons,[1] of which over ten thousand million tons exists in the almost untouched deposits of the Western States of Utah, Idaho, Wyoming, and Montana. There is no prospect, therefore, of a failure of phosphate supplies in the United States, even if the present consumption increases many times over.

Though the North African deposits do not produce quite so

[1] International Institute of Agriculture, Bulletin of Agricultural Intelligence and Plant Diseases, 1915, p. 326.

much phosphate as those of the United States, Tunis increased its production in the ten years preceding the war even more rapidly than Florida, and had become during these years the greatest exporter of raw phosphate in the world. While the United States still produces more phosphate than North Africa, the greater part of that production is consumed at home. On the other hand, nearly the whole production of Tunis and Algiers is exported, chiefly to the markets of Europe, of which it now forms the principal source of supply.

With regard to the consumption of phosphates there is much the same tale to tell as with regard to nitrogenous manures. Britain, which at one time occupied a leading position as a consumer of mineral phosphates, has in comparatively recent times been passed by several other countries, and is not increasing her consumption nearly so rapidly as most other civilised countries. This is illustrated by Table XII., which gives the import of raw phosphates for several of the chief consuming countries in 1905, 1910, and 1913, taken from statistics published by the International Institute of Agriculture.

TABLE XII.

IMPORTS OF RAW PHOSPHATES.

(METRIC TONS.)

	1905.	1910.	1913.
United Kingdom . . .	427,744	462,904	547,666
France	446,722	687,673	940,791
Germany	501,048	723,271	928,798
Italy .	240,144	422,714	529,776
Japan .	88,932	168,231	331,288
Australia	15,575	107,300	162,599

The table shows that the import of phosphates by European countries like France, Germany, and Italy, as also the import by countries like Japan and Australia, was, before the war, increasing at a far more rapid rate than was the import by the United Kingdom. In addition to her import France uses at home most of the large amount of raw phosphate produced in the country, and is the largest consumer of mineral phosphate in Europe, though Germany is not far behind. The largest consumer of all countries is the United States, which is increasing her consumption with great rapidity.

Mineral phosphates are used mainly for the manufacture of superphosphate, only small quantities being used directly as manure and for other purposes. The manufacture of superphosphate is, then, the use to which nearly all of the mineral phosphate is put, and it is as superphosphate, or as mixed manures containing superphosphate, that nearly the whole of it is con-

sumed in agriculture. Table XIII., the figures for which are taken from the returns of the International Institute, shows the production of superphosphate in some of the chief producing countries, and tells a similar tale to preceding tables. In France, Germany, and Italy the production has grown with astonishing rapidity, and the same is true of most of the countries which produce smaller quantities, while in Britain the growth of production is only moderate. The case of the United States is the most remarkable of all. Complete figures are not given, but the production in 1904 is stated at 695,068 tons, and in 1909 at 1,089,600 tons.[1] The production has therefore increased nearly fivefold in ten years, and in 1913 far exceeded that of any other country in the world.

TABLE XIII.

PRODUCTION OF SUPERPHOSPHATE.

(Metric Tons.)

	1900.	1903.	1905.	1910	1913.
United Kingdom . .	621,000	655,200	772,200	756,900	8[illegible]0,000
France	945,000	1,053,000	1,314,000	1,634,400	1,920,000
Germany . . .	644,400	765,000	873,000	1,353,000	1,818,700
Italy	252,000	392,400	480,000	1,050,200	972,500
United States . . .	...	...	..	...	3,248,000

The world's production in 1913 is estimated to have exceeded eleven million tons. By far the most important use of sulphuric acid before the war was in the manufacture of superphosphate.

The greatest rival of superphosphate in recent times has been basic slag. This is a by-product of the purification of steel by the basic process. It began to be produced at Middlesborough by the Thomas-Gilchrist or basic modification of the Bessemer process in 1879, and was for some time a waste product. Its value was soon recognised in Germany, and the slag produced in Britain was for a time entirely exported to Germany. Even up to the outbreak of war much of the slag produced in Britain was exported. The basic process of steel manufacture proved of much greater advantage to the steel industry of Germany, Belgium, and Luxemburg, than to that of the country of its origin, and in a few years Germany was producing far larger quantities of basic slag than the United Kingdom. Also the use of slag in agriculture became popular in Germany very rapidly,

[1] Production et Consommation des Engrais Chemiques dans le Monde, p. 54.

and the consumption of slag in that country has always far exceeded that of any other country. Even when its value began to be recognised in Britain, the supply of the material remained for years largely in the hands of German firms. It was from the late German firm of H. & E. Albert, London, that the following figures showing the world's production of slag up to 1900 were received.

TABLE XIV.

WORLD'S PRODUCTION OF BASIC SLAG.

Year.	Tons.
1880	10,000
1885	150,000
1890	410,000
1895	845,000
1900	1,760,000

The production of slag in Germany, including Luxemburg,[1] was 4326 tons in 1880, 358,320 tons in 1890, and 953,370 tons in 1899.

The increase in production in the chief producing countries since 1900 is shown in Table XV., the figures for which are taken from the returns of the International Institute of Agriculture.

TABLE XV.

PRODUCTION OF BASIC SLAG

(Metric Tons.)

	1900	1905.	1910.	1913.
United Kingdom	123,000	211,500	260,000	404,000
France	230,000	338,000	534,000	
Belgium	112,000	225,000	488,000	655,000
Germany (including Luxemburg)	1,035,300	1,551,000	2,007,000	2,500,000

The net export of slag (export less import) is shown for the chief exporting countries in the next table.

TABLE XVI.

NET EXPORT (EXPORT LESS IMPORT) OF BASIC SLAG.

(Metric Tons.)

	1905.	1910	1913.
United Kingdom	...	218,134	115,796
Belgium	213,240	422,644	541,354
Germany	72,142	71,366	272,809

[1] Jour. Socy. Chem. Ind., 1901, xx. 521.

The tables show that Germany consumed nearly the whole of her immense production of slag, while, in spite of her moderate production, up to the outbreak of war, Britain exported a considerable proportion of what she produced. Belgium had by far the greatest net export, but still retained a considerable quantity for home use relatively to her small acreage.

Potash Manures.

Until recent times the ashes of plants and the lees of wine formed almost the only sources of potash and its salts. Nitrate of potash or nitre was obtained as an efflorescence from certain soils in India and some other hot countries; but most potash compounds, whether for use as manure or for other purposes, were obtained from wood ash, kelp—the ash of seaweed,—barilla, and other such sources, or from the tartar or argol of wine. The great German deposits of potash salts began to be developed about 1860, and since then the German potash industry has continually grown and increased until it had before the war almost a monopoly of the world's supply of potash salts for use as manure and for other purposes. The industry was developed with the help of the Prussian Government, which had a direct interest in the mines. All the producing companies were formed into a syndicate, which regulated production and prices, and conducted a thorough, well-organised and scientific propaganda, at first in Germany itself, then in Western Europe and the United States, and latterly throughout the whole world. Probably no branch of the fertiliser industry has been so thoroughly controlled and organised as the potash industry, and in the use made of agricultural science for propaganda purposes it has been the model and example which has been distantly followed in recent times by older branches, such as those which deal with nitrate of soda, sulphate of ammonia, and mineral phosphates.

The older, badly organised potash industries, such as the kelp industry, had before the war almost ceased to struggle against this great, well-organised syndicate. Until the United States, owing to a fiscal dispute, began a few years ago to search seriously for home sources of potash compounds, all countries seemed to be content to draw their supplies from the unlimited stores of the organised and efficient German syndicate, and to allow any feeble home potash industry they had to go to the wall. From this lethargy we have recently been roused by the war, and the scarcity and rapid rise in price of potash compounds has caused feverish activity in the search for independent sources of these valuable products.

The German Potash Syndicate has always published very complete statistics of its production and export of potash compounds, and has freely used these throughout the world for propaganda purposes. There was therefore little difficulty in obtaining complete returns of the production and consumption, before the war, of the Syndicate's products in agriculture and industry throughout the world. These statistics, naturally, make no mention of potash compounds derived from other sources, but during the past twenty years, at any rate, production from all other sources was very small in comparison with the German production.

The following table, compiled from statistics published by the Syndicate before the war, shows the rapid and continuous growth of the industry from 1861 onwards:—

TABLE XVII.

GERMAN PRODUCTION OF POTASH COMPOUNDS.

(Metric Tons.)

	Crude salts	Concentrated salts.
1861	2,293	...
1865	89,060	...
1870	288,598	...
1875	522,866	...
1880	668,596	...
1885	929,050	144,850
1890	1,279,265	209,961
1895	1,531,585	212,558
1900	3,037,035	409,582
1905	4,878,598	579,448
1910	8,160,778	1,124,629
1913	11,607,510	1,647,906

The crude salts are the raw salts as raised from the mines. These are partly used as fertilisers without further treatment, except grinding and grading, and partly used for the manufacture of such concentrated salts as muriate of potash and sulphate of potash. Under "Crude Salts," in Table XVII., is included the well-known manure kainite. The chief crude salts raised from the mines are carnallite and kainite. Carnallite is used chiefly for the manufacture of the concentrated salt muriate of potash.

The chief concentrated salts produced are muriate of potash and potash manure salts. Sulphate of potash is produced in much smaller, though still large quantities.

The table shows that the expansion has been specially rapid since 1905, both for crude and for concentrated salts. During

the eight years, 1905-1913, the production of crude salts has increased at an average rate of over 800,000 tons per annum, and the manufacture of concentrated salts at an average rate of over 130,000 tons per annum. These are remarkable figures, and indicate the possibilities of the potash industry in the future and the importance of developing all independent economic sources of potash salts.

By far the most important use of potash salts is in agriculture. In the earlier days of the industry the German potash salts were used principally in industries other than agriculture, but the Syndicate soon recognised that their greatest field for expansion was in agriculture, and both at home and abroad they have diligently cultivated the agricultural market. The great expansion in the industry shown in Table XVII. has been mainly due to the increase in the agricultural use of potash. This is illustrated in Table XVIII., in which all German potash compounds are reduced to the common terms of pure potash, which gives the best basis of comparison for such a purpose.

TABLE XVIII.

CONSUMPTION OF POTASH IN AGRICULTURE AND INDUSTRY.

	1880.	1890.	1900.	1910.
	tons.	tons.	tons	tons.
Pure Potash used for AGRICULTURAL purposes	29,127	71,679	255,722	766,584
Pure Potash used for INDUSTRIAL purposes	39,453	50,623	70,257	91,299
Per cent used for AGRICULTURE .	42·4	58·7	78·4	89·3

In 1880 only 42·4 per cent of the German production of potash was used for agriculture, while in 1910 almost 90 per cent of the enormously increased production was used as fertiliser, and the use in all industries other than agriculture was relatively small. Putting it another way, in the thirty years from 1880 to 1910 the consumption of German potash in all industries other than agriculture was a little more than doubled, while the agricultural consumption increased more than twenty-six fold.

Germany is the chief user of her own potash salts, whether for agriculture or otherwise. In Table XIX. some statistics for recent years are given in terms of pure potash.

TABLE XIX.

CONSUMPTION OF POTASH IN GERMANY AND OTHER COUNTRIES.

STATED IN TERMS OF PURE POTASH IN METRIC TONS.

	Agriculture.		Industry.	
	Germany.	All other countries.	Germany.	All other countries.
1903 . .	153,630	147,784	39,370	25,636
1906 . .	228,485	241,883	48,731	28,435
1909 . .	305,960	284,067	55,281	32,024
1911 . .	422,341	426,060	57,498	34,028

Germany uses practically as much potash for agricultural purposes as all other countries put together, and uses much more than all other countries for other industries. These figures, which are derived from the statistics of the Potash Syndicate, do not take account of potash produced in other countries than Germany, such as the potash derived from kelp in this country and Japan, and the nitrate of potash produced in India. As already pointed out, however, the production from these sources is small, and would not make a very serious alteration in the figures given in the table. The increase in the consumption has proceeded fairly equally both in Germany and in other countries, whether for agriculture or for other industries, and both in Germany itself and in other countries it is the agricultural market which is the important one.

After Germany, by far the most important consumer of potash salts is the United States, and, before the supply was cut off by the war, the market there was rapidly expanding. Other important consuming countries were the United Kingdom, France, Belgium, Holland, the Scandinavian countries, and Austria-Hungary. In the United Kingdom the consumption increased rapidly between 1900 and 1913. Per acre of arable land Scotland was one of the chief consumers of potash manures before the war, though much Scottish soil stands less in need of special potash manuring than the light potash-hungry soils which form such large areas in Germany itself, and others of the chief potash-using countries.

In spite of the predominance of the German potash industry, the manufacture of potash compounds from seaweed ash or kelp survives to a certain extent in Scotland. It has not been found possible to obtain exact figures of the production of potash salts from kelp, but it probably amounts to two or three thousand tons of concentrated potash salts per annum. This industry could, no doubt, be considerably developed.

Other Manures.

Besides the great classes of Nitrogenous, Phosphatic, and Potassic manures discussed above, there is a very large trade in a number of other fertilisers, several of which are organic waste products from other industries. In addition to the industry in real guano, which is composed of the dung and waste of sea-birds, there is a considerable industry in substances called guano, the chief of which is fish manure or fish guano, made from fish refuse. The net import of guano —import less export—calculated from the returns of the International Institute of Agriculture for the years 1905, 1910, and 1913 for the chief importing countries, is shown in the following table:—

TABLE XX.

NET IMPORT (IMPORT LESS EXPORT) OF GUANO, NATURAL AND ARTIFICIAL.

(Metric Tons)

	1905.	1910.	1913.
United Kingdom .	26,810	15,035	22,590
France .	5,498	2,079	1,035
Belgium .	8,735	10,721	20,095
Germany .	71,485	40,244	55,792
United States .	26,063	44,978	19,412

That these imports of guano are largely made up of artificial guanos, such as fish guano, is evident from the following considerations: (1) The total production of natural guano in Peru in 1913 was 74,707 metric tons, of which 37,177 tons were reserved for home consumption, the other 37,530 tons being exported. The production of natural guano elsewhere was about 6000 tons in South Africa, and 2100 tons in the New Caledonian islands. The total export of natural guano, therefore, did not exceed 46,000 tons in 1913. The net import shown in Table XX. for the same year was nearly 120,000 tons. (2) In the returns Norway figures as an exporting country, and is not an importer. The only guano exported by Norway is fish guano. The quantity exported by Norway in 1913 was 14,214 tons.

In Table XX. Belgium has a minus import of over 10,000 tons in 1910. This is accounted for by the fact that large quantities of manure, as of other substances, pass through Belgian ports into Germany. In 1910 the Belgian import was below the average, but there were specially large imports in 1909 and 1911.

A class of manures, of which there is not only a very large production and internal trade, but a very large international trade, consists of organic nitrogenous materials of animal and vegetable origin. The chief of these manures of animal origin are prepared from horns, hoofs, wool waste, hair, feathers, blood, skin and leather, while the chief vegetable products are cakes and meals left as by-products after the extraction of oil from certain oil-seeds. Such materials have been used as manure to a certain extent since early times, long before the present great industry in mineral or chemical manures had its origin. Thus we find that Davy, in his 'Elements of Agricultural Chemistry,' published in 1813, not only mentions the use of fish refuse as manure, but also points out that horn, hair, feathers, woollen rags, rape-cake, and malt dust all form valuable manures. He states that Mr Coke of Holkham, who was so well known in the history of the improvement of agriculture in the East of England, brought the practice of the use of rape-cake as a manure for turnip crops to "its highest degree of perfection."

At the present day there is still a considerable industry in these articles, some of which are very popular and trusted manures in certain districts. Rape-dust or rape-meal, for instance, is extensively used as a manure in certain parts of England, and in India large quantities of castor-cake and meal are used. In the International Returns of Imports, Germany and France appear as the largest importers of animal refuse materials. Germany is stated to have imported in 1913, 2899 tons of residues of horns and hoofs for manurial use, and 64,421 tons of "various animal residues"; while France imported in the same year 82,044 tons of "various animal residues."

All these figures, however, are dwarfed by the enormous import by Japan of soya-bean cakes and other oil-cakes for use as manure, which in 1913 amounted to 859,008 tons. Such cakes are the principal concentrated manure used in Japan. We have seen above that in recent times Japan has rapidly increased her consumption of chemical fertilisers — such as sulphate of ammonia and superphosphate—but the traditional imported manure used in that country is bean-cake, which is imported mainly from China. Japan also appears in the returns as having imported, in 1913, 4820 tons of "various animal residues." The above figures show that the international exchange of oil-cakes for fertilisers is a very large industry in the far East, and must employ a great amount of shipping.

Lime.—Though very large quantities of lime are applied to the soil in different countries, practically it is not an article of international exchange. Though statistics can be obtained in different countries of the production of lime, much of this

lime is used for industries other than agriculture, and there is no means of determining how much is used for agriculture and how much for other purposes.

We are safe to say, however, that since 1880 the use of lime for agriculture in Britain has diminished, and in this respect we have not progressed, but have gone seriously backwards.

To sum up the position with regard to manures, the whole of the statistics show that, since 1880, an enormous development has taken place in the world's fertiliser industries, and a great world-wide commerce has sprung up in materials for making fertilisers, and in the finished fertilisers themselves. Fertilisers are now consumed in millions of tons per annum in the chief countries in which intensive agriculture is pursued. The United States, for instance, which is stated[1] to have consumed in 1880 1,150,000 tons of fertilisers, and to have increased this consumption to 2,200,000 tons in 1900, developed the industry at a greatly increased ratio after that date, and, according to the official census of production, produced 5,096,778 tons in 1909, and 7,633,925 tons in 1914, an increase of nearly 50 per cent, or over two and a half million tons in five years. During this period of development the growth of the British production and consumption of fertilisers has been relatively slow.

Increase of Crop Production.

Fertilisers are used to increase crops. Farmers would not go to the expense and trouble of using them if they did not consider that they would obtain a return from their use sufficient to recoup themselves. Consequently we may expect that those countries which are rapidly increasing their consumption of fertilisers are also increasing their crop production, and this we find to be the case.

It is not the intention to deal with this question at any length in the present paper, but some illustrations of how crop production per unit of area increases with increased consumpt of manures, which have a particular and important relation to the present crisis in our national history, may perhaps be given.

The population of the great developing countries of the world, such as Britain, the United States, and Germany, has been rapidly increasing with the development of modern industries, and the consequent growth of towns. Both the increase of population and the increase of wealth, which brings with it a higher standard of living and a consequently greater consumption of food, call for an increased food supply. This can be met in two ways: (1) by increasing

[1] American Fertiliser Handbook, 1914.

the production of the land of the country; (2) by importing food from other countries. In the case of a great new country like the United States production can be increased in the country by breaking up new land, and also by more intensively cultivating land which is already under the plough. Both of these methods are being used to increase the food production in that country, which, probably for a long time to come, will be able to face with equanimity the question of food supply from home sources.

The case is quite otherwise in the highly industrialised countries of Western Europe, which have no great reserves of land to bring under the plough. To increase their food supply they must either increase the intensity of their cultivation, by increasing their use of manures and by other methods, or they must import,—or they may do both. Britain and Germany stand out in sharp contrast as to the policies they have pursued in this matter. Britain has depended on the importation of food, and has been content to let her home agriculture decline, while Germany has pursued the contrary policy, and has taken great trouble to stimulate home agriculture and increase the home production of food. A point may of course be reached where home food production is unable to keep pace with increase of consumption, no matter how highly the land may be farmed. In that case a nation must import food to supplement the home production. Belgium, which before the war was probably the most highly industrialised and probably also the most intensively cultivated country in Europe, was an example of a nation which had reached that stage. Although in all the principal crops Belgium headed the list for production per acre, and carried nearly twice as many cattle per 100 acres as Great Britain, she, like Great Britain, had to import much food to maintain her population, which was of far greater density than that of Great Britain and about twice as dense as that of Germany. In writing of Belgium one must use the past tense, for it is impossible to say what the present condition of that martyred country may be, though we know that for the time her prosperity is blotted out.

Great Britain is the greatest importer of foodstuffs in the world. We import far more food, and employ far more shipping to carry it, than any other country in the world. Britain was the first country to become highly industrialised. For a time agriculture improved along with other industries. With the development of new countries and the increase and improvement of means of communication, however, a time came when agricultural products from these new countries, or from non-industrialised lands like Russia and India, began to compete seriously with the products of home agriculture. This country deliberately adopted a policy of free imports

and cheap food, and at the same time made no effort, by education and research, and by organisation of agricultural industries, to assist the home cultivator to compete with cheap foreign produce. The results are well known. Great areas of arable land went out of cultivation, and in spite of cultivation being restricted to the better lands, production per acre did not increase to any appreciable extent, but in some cases went back. The total wheat area of the United Kingdom, which in the five years 1870-1874 averaged about 3¾ million acres, diminished to about 1¾ acres in 1913, yet there was very little increase in production of wheat per acre during this period.

Fifty years ago Germany was far behind Britain both as an industrial and as an agricultural nation. After 1870 she made rapid progress in industry, and her population rapidly increased. Like the other great nations of western Europe, with the exception of Britain, she also endeavoured to improve her agriculture by adopting a widely spread state-supported system of agricultural education and research, and by encouraging and giving state backing to various bodies which assisted in the organisation and capitalisation of agriculture. A time came, however, when, despite these efforts and the great results they produced, the increase in population overtook the increase in agricultural production, and a lengthy and bitter controversy took place as to whether Germany should foster her agriculture or follow the example of Great Britain and sacrifice her agriculture for the sake of industry and commerce. During the Chancellorship of Count von Caprivi it seemed likely that the British example would be followed; but this policy was reversed under Prince von Bülow, and what has been called a "plough policy" was adopted, and made the fixed policy of the country. The reasons which induced von Bulow to adopt this policy are fully set out in his book 'Imperial Germany.' The consequence has been that since early in this century German agriculture has been specially fostered, not only by state-supported education, research, and organisation, but by the fiscal arrangements of the country, and has continued to increase its powers of production. Along with, and largely in consequence of, the increase in the use of fertilisers which has been illustrated in earlier tables, Germany has steadily increased her production per acre, till now her production per acre of most of the principal crops grown in both countries exceeds that of Britain, although she has not, like Britain, been restricting her production to the better soils, but has been increasing her arable acreage. This is illustrated in the next two tables, the figures in which are taken from an important pamphlet by Mr T. H. Middleton, published last year by the Board of Agriculture and Fisheries.[1]

[1] The Recent Development of German Agriculture, by T. H. Middleton, C.B. 1916. Cd. 8505.

TABLE XXI.

CROP PRODUCTION. GERMANY.

Five-year Period.	Average total Production. Million tons. Cereals.	Average total Production. Million tons. Potatoes	Average Production per Acre. Centals. (100 lb). Cereals.	Average Production per Acre. Tons. Potatoes.
1879-83 .	13·2	21·1	10·24	3·05
1889-93 .	15·2	25·3	10·87	3·48
1899-1903	22·5	42·1	15·53	5·28
1909-13 .	26·9	45·0	17 86	5·46

TABLE XXII.

COMPARISON OF YIELD OF CROPS.

	Per Acre per Annum. England and Wales. 1885-89.	England and Wales. 1909-13.	Germany. 1883-87.	Germany. 1909-13
Wheat (bushels)	29·5	31·2	19 8	31·6
Barley "	32·4	32·7	22·7	36·7
Oats "	38·8	39·0	25·7	44·6
Potatoes (tons) . . .	5·9	6·2	3·4	5·4
Meadow Hay (cwts.) . .	26 1	23·1	22·5	33·7

Table XXI., which gives averages for five-yearly periods, shows that in the thirty years, 1879-83 to 1909-13, the German production of cereals and potatoes more than doubled, and that this increase was more due to increase of production per acre than to increase of arable acreage. Table XXII. gives a comparison, between England and Wales on the one hand and Germany on the other, as to the increase per acre in the production of the principal crops grown by both during a period of about twenty-five years. It will be seen that in all crops, except potatoes, the German production in 1909-13 has passed that of England and Wales. It is also to be remembered that there are in Germany under arable culture great areas of very poor light land which grow principally rye and potatoes, while

in this country potatoes are not generally grown on such poor soils. These great increases of crop per acre are to be largely accounted for by the increased use of fertilisers. During the period when the great increase in production per acre took place, 1890 to 1913, the annual consumption of fertilisers in Germany increased from about 1,600,000 tons to over 7,000,000 tons As Lord Selborne, the then President of the Board of Agriculture and Fisheries, pointed out last year, the war is being fought by our great enemy, Germany, "as much on an agricultural as on a military organisation of the nation," and, he said truly, "if agriculture had made no more progress in Germany than it has in the United Kingdom during the period 1895-1915, the German Empire would have been at the end of its food resources long before the end of the second year of the war."

While the United Kingdom imports the greater part of the food which it consumes, and especially of the staple foodstuff wheat, Germany is able to produce at home by far the greater part of the food which she requires. Table XXIII., which gives Mr Rew's estimates[1] for the five years 1910-14, shows the extent to which our staple foodstuffs are produced in the United Kingdom, in the British Empire overseas, and in Foreign Countries.

TABLE XXIII.

COMPARISON OF IMPORTS AND HOME PRODUCTION.
1910-14.

	United Kingdom.	British Empire Overseas.	Foreign Countries.
	Per cent.	Per cent.	Per cent.
Wheat	19·0	39·3	41·7
Meat	57·9	10·7	31·4
Poultry	82·7	0·2	17·1
Eggs	67·6	0·1	32·3
Butter and Margarine	25·1	13·3	61·6
Cheese	19·5	65·4	15·1
Milk and Cream	95·4	...	4·6
Fruit	36·3	8·3	55·4
Vegetables	91·8	1·1	7·1

Many thought at the outbreak of war that we should be able rapidly to bring Germany to extremities by cutting off her sea-borne food supplies. In spite of repeated disappointments there seem to be many as ready as ever to believe that we are doing so. A study of the International Statistics of crop production indicates that, provided Germany is able to maintain her cultivation and does not suffer from disastrous harvests,

[1] Journal of the Board of Agriculture, xxii. p. 514, 1915.

she should be able to maintain herself in essential foodstuffs, like cereals and potatoes, no matter how long the war may last.

For the purpose of a comparison, Germany and Austria-Hungary, the Central Powers, have been classed together in Table XXIV. on the one hand, and the United Kingdom and France on the other. Presumably Germany and Austria-Hungary can freely exchange foodstuffs with one another, as well as with Holland, Denmark, the Scandinavian countries and Switzerland, although they are cut off from overseas trade. The figures in Table XXIV. have been drawn from '*Annuaire International de Statistique Agricole, 1913 et 1914.*'

In Table XXIV. wheat and rye are grouped together as "bread corn." Rye is the chief cereal food of the German people, who do not produce nearly so much wheat as Austria-Hungary or France, but produce more rye than all the others put together. In Britain, France, and Austria-Hungary wheat is the staple cereal food. Before the war Germany imported a large amount of wheat, about 2-5ths of her consumption, but it does not follow, as was rashly concluded by many, that in case of war Germany can produce bread to feed herself for only about seven and a half months of the year. Her bread is mainly rye-bread, and she imports no rye, but in normal times uses great quantities of rye as food for stock. In war, when her import of wheat is largely cut off, she can eat less wheat- but more rye-bread, and use less rye as food for stock. That may cause her stock to diminish, and so diminish the supply of animal food, but, after all, animal food is a luxury, not a necessity.

TABLE XXIV.

AVERAGE FOOD PRODUCTION BEFORE WAR. 1905 TO 1914.

POPULATION, MILLIONS.	Germany. 67·8	Austria-Hungary. 49·6	Total. 117·5	United Kingdom. 46 4	France. 39·6	Total. 86·0
Wheat, million tons . .	3 95	6·21	10 16	1·61	8 90	10·51
Rye, ,, . .	10 67	3·95	14·62	·01	1·30	1·31
Bread corn ,, . .	14·62	10·16	24·78	1·62	10 20	11·82
Barley, ,, . .	3·24	3·14	6·38	1·45	1·00	2·45
Oats, ,, . .	8·38	3·56	11·94	3·03	4·98	8·01
Maize ,, . .	...	4 93	4·93	...	.	...
Potatoes ,, . .	45·76	18·57	64 33	6·82	13 53	20·35

The main deduction to be drawn from Table XXIV. is that before the war the Central Powers normally produced more than

twice as much "bread corn" as France and the United Kingdom taken together, and also more than twice as much of the total of the other cereals—barley, oats, and maize—and more than three times as much potatoes. The population of the Central Powers, however, is greater than the total population of the United Kingdom and France. The next table (XXV.) shows the approximate production per head of the population of bread corn, other cereals and potatoes, calculated from the figures in Table XXIV.

TABLE XXV.

AVERAGE PRODUCTION PER HEAD OF POPULATION PER ANNUM. 1905 TO 1914.

	Central Powers.	United Kingdom.	France.
Bread Corn	460 lbs.	77 lbs.	570 lbs.
Other Cereals	440 „	210 „	330 „
Potatoes	1200 „	320 „	750 „

It is a reasonable deduction from this table that, if the Central Powers have been able during the war to maintain a production of cereals and potatoes equal to their average for the ten years preceding the war, they have sufficient of these staples to feed their population without importing from surrounding countries, for they have nearly 1¼ lb. of bread corn and over 3 lb. of potatoes per day for every individual in the population. These should leave a considerable balance of offals and potatoes, as well as of "other cereals," for stock food, and so enable them to maintain, with the help of their forage crops, their horses and a considerable head of stock to yield milk and other animal foods. No doubt there are difficulties of distribution, and difficulties in rapidly altering the whole trade and organisation of the country so as to turn products capable of being used as food, but ordinarily used for other purposes—such as brewing, spirit production, starch production, and so forth—into the new channels necessary to secure their use as food for the population. No doubt, also, the people have to alter their customary diet and endure a good deal of hardship from lack of foods to which they have been accustomed. All this is on the assumption that the harvests do not fail and that cultivation is maintained, and these are matters concerning which it is difficult to obtain accurate and unbiassed information.

The case of France seems to be somewhat similar. The figures indicate that under war conditions, when a patriotic population is prepared to restrict its dietary and live frugally on simple foods, that country also is able to produce sufficient of

the staple foods, cereals and potatoes, to feed the population without importing from other countries.

The case of the United Kingdom is far otherwise. The production of bread corn is only a small fraction of what is required. Even if the whole of the other cereals could be used as human food, they would not be sufficient to meet the deficiency; further, this is not possible, as oats must be used, at least to some extent, for horses and other stock. The production of potatoes is nearly sufficient to meet the normal needs of the population, but there is no margin to meet the case of a deficient crop, such as we had in 1916. It is therefore of the utmost importance that, by the increased use of fertilisers and by increasing the area of arable land, the production of cereals and potatoes should be increased—not by a small percentage, but to an extent which will seriously alter the system of agriculture in this country.

It is also of the utmost importance that the supply of fertilisers should be maintained and even increased. Fertilisers like basic slag and sulphate of ammonia, which are produced in the country, should not be exported if they can be used at home. It requires less shipping to import fertilisers than to import an amount of food equivalent to what can be grown by the proper use of fertilisers. Therefore it is, within limits, more economical in shipping to import fertilisers than to import food. The authorities should see to it, therefore, that a sufficient supply of all necessary fertilisers—such as mineral phosphates—which are not produced at home, is imported. It is even more important to use shipping for this purpose than to use it for importing food.

Prince von Bülow insisted with the German people that "in time of war the productive power of agriculture is a vital question for the whole nation." We are learning this lesson under the stress of war. In the edition of his book, 'Imperial Germany,' published since the war broke out, von Bülow writes: "Germany was spared the catastrophe which would overtake England, and that by the productiveness of German agriculture. Certainly not without difficulty, but nevertheless with complete success, since the beginning of the war German agriculture has solved the mighty problem of feeding the whole German civil population, the millions of German soldiers, and the millions of prisoners of war, with the products of German husbandry and cattle-breeding. This tremendous achievement is mainly rendered possible by the unparalleled development of intensive culture in Germany." These words from an enemy convey a lesson for us.

THE INHERITANCE OF MUTTON POINTS IN SHEEP.

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THIS paper deals with part of an investigation which arose out of Wood's work on the Inheritance of Face-colour and Hornlessness in Sheep. Some Australian flock-masters, seeing the results of that work among the stock on the Cambridge University Farm, became desirous that Mendel's theory should be further tested in experiments upon sheep. In particular, they wished to ascertain if, or to what extent, it was possible to combine the Merino fleece with the good mutton characters of the Shropshire. These gentlemen, on returning to Australia, selected and despatched in the spring of 1909 a couple of high-grade Merino rams as a present to the Cambridge School of Agriculture. The latter, through the courtesy of Mr Alfred Mansell, obtained by purchase a score of flock Shropshire shearling ewes. The two Merino rams differed in type, and among the ewes there was the amount of variation such as usually exists with such stock—that is to say, they were not as symmetrical in fleece or in shape as would probably have been the case had they been ewes picked out from any first-class flock for show in any one year. The differences between the carcases of the Shropshire ewes and those of the Merino rams were, however, very wide, being quite as marked as in the case of their respective fleeces, and that difference is well known to be very great.

The accurate recording of the detail of each mutton point, so that it became possible to trace its inheritance through more than one generation, was, to any one accustomed to judging stock, obviously a difficulty which entailed pioneer work.

We first decided to try and overcome the difficulty by means of accurate measurement. This system demanded very considerable practice to ensure anything like accuracy, while the results obtained were liable to variation, due to any slight movement on the part of the sheep, and had always to be considered with reference to the condition or state of fatness of the several animals which were dealt with. Nevertheless, and notwithstanding many obvious errors, we continued to make

measurements for several years, and a large number of figures were compiled.

However, it became obvious to us that, as regards practical use at any rate, our pioneer measuring work did not accurately bring out what was required. We hope, after the war, to profit by the experience gained, and recommence a series of more useful and certain measurements.

Theoretical Considerations.

We were further confronted at the outset with tho difficulty as to whether any of the points with which we intended to deal could be regarded as "unit characters," and whether, if it were possible so to regard them, they were capable of being transmitted according to Mendelian expectation. In order to appreciate our difficulty it is necessary to understand what the Mendelian theory postulates, and how the views which we have adopted are liable to become altered when we consider the animal organism not merely as a mass of hypothetical units shaken together in chance combinations, but as an organic whole, each part, in respect of its functions, exercising an influence (sometimes great but sometimes insignificant) upon every other part.

As is well known, Mendel's original experiments were upon hybridisation or crossing with different varieties of peas, the two varieties initially selected differing from each other in particular characters, such as tallness or dwarfness.[1] The hybrids produced by crossing all resembled one another superficially, but, when intercrossed among themselves, gave rise to peas which in every respect resembled one or other of the two original grand-parental stocks. They also gave rise to peas identical with the parent hybrids, the three varieties occurring in the numerical proportion 2 : 1 : 1, the hybrids being equal in number to the sum of the other two (grand-parental) varieties. Mendel drew the conclusion that in the hybrid the gametes or reproductive cells (both male and female) were of two kinds, which were respectively identical with the two kinds represented by the gametes of the original pure varieties. Thus the hybrid or cross-bred variety was what is now sometimes called a "splitter"—that is to say, it produced more than one kind of gamete or germ cell carrying its own distinctive character. Proceeding on this theory, Bateson and Punnett have found that the Blue Andalusian fowl is invariably a splitter; it gives

[1] For a fuller account of Mendel's theory, and of various experiments by subsequent investigators upon the phenomena discovered, see Wood and Punnett, "Heredity in Plants and Animals," Trans. Highland and Agric. Society, vol xx., 1908.

off two sorts of gametes, and when similar gametes unite together they give rise either to black individuals or to others which are "splashed-white," according to the character borne by the gametes. It is only when gametes of each of these kinds unite together that they produce blue individuals like the parents; but these offspring are also splitters, and the process is repeated in each generation. Innumerable instances of phenomena of this class might be cited from both plants and animals. Moreover, there are reasons for suspecting that certain high-class pedigree bulls belonging to dairy breeds may be splitters, and produce two sorts of gametes giving rise to high milkers or low milkers among their female progeny.

Among plants, where the metabolism is relatively simple, it is not difficult to regard the organism as the possessor of a number of unit characters, such as Mendel dealt with in peas, and there is experimental evidence to show that each or any of these characters can be removed and replaced by others without affecting—or at any rate appreciably affecting—those which remain. Among animals the problem is not so easy, owing to the almost infinite number of internal secretions and products of metabolism which, though produced in one part of the organism, travel to almost every other part. Consequently, in the case of an animal, it must be very difficult to alter or remove one feature without modifying other features, since the part or organ presenting the character in question is continually producing metabolic products (that is, products of secretion or excretion), which are carried by the circulating blood to the other parts of the body. According to this view, the presence of any one characteristic may exert an influence upon many, if not all, the other characteristics, and even in heredity one can hardly hope materially to alter any single organ or structure without affecting, in some slight degree at any rate, all or nearly all the organs of the body. A consideration of these principles makes it harder to apply the Mendelian conception of unit characters to animals than to plants, and it is only what a physiologist would expect when we find that the unit characters which are most readily and certainly transmitted pure in cross-breeding experiments with animals are the superficial characters, such as the colour of the pigment of the hair and eyes, or the presence of horns or hornlessness. Furthermore, even in the experiments by Wood, in which he succeeded in two generations in superimposing the hornlessness of Suffolk sheep upon the white face of the Dorset Horn variety, the matter was subsequently found to be more complicated than it had at first appeared, since some of the hornless sheep were found to have grown rudimentary horns or "scurs."

Our difficulty in the investigation now described is that the

characters with which we were dealing were deep seated and not superficial. Nevertheless, we are justified in saying that though we cannot be certain that any of them have been transmitted "pure" to the third generation in the same way as has been accomplished with more superficial or less complex characters, yet the "points" of the original parental breeds have in a great many cases reappeared in new combinations in both the first and the second crosses in such a manner as to compel recognition by any one experienced in appraising the mutton points of a sheep.

In recent years, investigators in heredity have to a great extent substituted the expression "unit factor" for that of "unit character," but with a certain important difference in meaning. For the factor is what is supposed to be actually transmitted, the character being merely the manifestation under which the factor appears. Thus a couple of unit characters may be structurally or physiologically incompatible, and yet the factors which in other animals are responsible for the appearance of those characters may in reality be present, though obscured. The new combination of unit characters in an apparently pure or unaltered state can only be brought about when the metabolism admits of it; otherwise one or other of them becomes partially or entirely suppressed, or it may be only slightly altered. It seems to us a very promising field of work for the biometrical school of Biology to determine by statistical methods the extent to which variation can occur as a result of attempted superposition of "unit" characters which in their "pure" state are structurally or physiologically incompatible, and we venture to suggest that such an investigation would be of great value in dealing with the inheritance of the mutton points of sheep. Moreover, it would be well worth while for any one possessing the time and opportunity, together with the requisite knowledge, to ascertain the precise extent to which certain structural features are habitually correlated in the domestic animals, and with what degrees of frequency such correlations exist, not only among cross-bred animals but among those which are believed to be pure-bred stock.

The Experiments.

In the summer of 1915 we had, for the first time, a considerable number of sheep, seventy-two, bred from the Merino-Shropshire cross, which it was possible to feed off simultaneously for the butcher. These sheep were all got, in reason, as fat as possible, so that the error due to difference in condition might be eliminated as far as such a thing could be done.

They were sent to market in lots as they became thoroughly fat or ripe, and each sheep was carefully handled for four different points. These four points were those which in the stockman's language are called: (1) Over the shoulder; (2) Behind the shoulder; (3) The loin; (4) The top of leg. These four points were selected because experience seemed to indicate that they differed in the two breeds—Merino and Shropshire—more emphatically than some others; and further, they were points that were easy to handle, or judge by touch, and were again least disturbed by the different attitudes taken up by the sheep when under examination. It is necessary to describe these four points in detail so that the following tables may be understood, it being assumed that the Shropshire "points" are good as regards mutton, and the Merino bad.

Over the Shoulder.

Over the shoulder the Shropshire is wide, level, and well covered with flesh. The Merino, on the contrary, is sharp, narrow, and not well covered; the latter expression meaning that the thickness of material found under the sheep's skin is not sufficient to prevent the finger from distinctly appreciating the lines of the skeletal structure. These differences are very marked, so much so that when handling these cross-breds there were some which it was quite easy to class as Merino or Shropshire without any reasonable fear of a mistake. But there were others which were not so easily classed. This being so, it becomes necessary here to give a description of the structure of the "point."

Like the other characters dealt with in this investigation, the point in question is obviously a complex one. To resolve it into all its component factors is at present impossible, and we must content ourselves with indicating the main structural features on which a good or a bad "top of shoulder" depend. In the first place, it is clear that the height of the spinous processes of the anterior dorsal vertebræ is involved. The spinous process of the first dorsal vertebra is always much shorter than the succeeding ones; from the second to the fifth or sixth the processes are of much greater length, and it is on the top portions of these that the rhomboideus muscle has its insertions. The fifth spinous process is generally the longest, and as we pass backwards the height of the remaining processes gradually falls. Secondly, the development of the point in question depends upon the height of the scapulæ and the relation that this bears to the length of the spinous processes of the dorsal vertebræ. Thirdly, it depends upon the extent to which the scapulæ converge towards the middle line—that is to

say, upon the distance between the highest part of each scapula. We have seen that all these skeletal characters are markedly different in the Merino from what they are in the Shropshire sheep. The differences also depend upon the development of the flesh or muscle and the extent to which the layers of muscle-fibre are separated by fat. It is obvious from what has just been said that the development of the rhomboideus muscle (which draws the shoulder upwards and forwards) is one of the factors concerned, since this muscle is attached by fixed insertion to certain of the spinous processes, and by its inferior extremity to the scapular cartilage. There are also other muscles involved; of these, the cervical portion of the trapezius[1] (which helps to move the shoulder) partly covers the rhomboideus: the latter covers the splenius (which extends the head and neck); the complexus muscle is attached to the transverse processes of the four or five dorsal vertebræ following the first, and to the spinous process of the first (and is a powerful extensor muscle of the head); the ilio-spinalis muscle (referred to again below) extends forward into this region so as to enter into the composition of the point.

A mention of these will be sufficient to indicate the complexity of the point so far as the development of the various muscles is concerned.

Now, in some of the animals under observation, the following conditions were found. The spinous processes were high, making the point sharp; on the other hand, the edges of the scapulæ were far apart, making the point wide though at the same time sharp. Or, again, it might be that the scapulæ came up quite close to the spine, making the point narrow, while the spinous processes were distinctly low, making the sheep level and narrow over the shoulder. All such cases we have called *composite* in the first three tables.

Further, there were eighteen animals which it was not possible to classify with any certainty: these we have looked upon as doubtful and recorded as such.

Behind the Shoulder.

"Behind the shoulder" is a part of the carcase which when good is of more importance to the butcher than the one we have just dealt with, though it is doubtful if, in placing sheep at a show, a judge would not appraise "over the shoulder" at a higher value as regards prize winning. This is probably due to the fact that most stock experts would look upon the part of the body covering the anterior ribs as the better general indica-

[1] The cervical trapezius enters more largely into the composition of the "scrag."

tion of the shape and condition of the whole body. The point "over the shoulder" is also, it may be worth noticing, often more emphatic in its goodness or badness than is the one called "behind the shoulder."

We found the Merino sheep distinctly different from the Shropshire in the structure or arrangement of the ribs. The Shropshire, as is more or less common to the breeds of its type (Southdown, Hants, Oxford), has all the ribs, from the first to the last floating one, well sprung. This statement must be taken with limitation, for in all breeds of sheep the ribs are not so spreading at the anterior as they are at the posterior end of the trunk. Now, if the Shropshire is regular in its spread of rib, the Merino, as judged by touch, is the very opposite. Immediately behind the shoulder, where for the first time the ribs can be felt, they are, or seem to be, badly sprung, but as the hand recedes from the head toward the lumbar region, the spread is felt to improve, so that the last or floating ribs seem at least as well spread as those of the Shropshire.

So that in the case of these two breeds we seemed to have quite an emphatic difference to judge.

Behind the shoulder the Shropshire was level, wide, or well sprung, leading to the showing of "no hollowness over the heart." The Merino was the reverse, being sharp, narrow, and hollow.

As already mentioned, the spinous processes of the dorsal vertebræ diminish in length as we pass backwards, for that of the last dorsal vertebra is hardly, if at all, longer than the process attached to the first lumbar vertebra. This is probably true of all varieties of sheep, but nevertheless we believe there is some variation in their length even in the hinder part of the dorsal region. The ilio-spinalis muscle is attached to all the spinous processes both of the dorsal and of the lumbar region, so that this muscle, which is probably the most powerful of all the muscles of the body, is an important factor in the development of the point described as "behind the shoulder." It is the extensor muscle of the vertebral column, and appears to play some part in expiration. The other muscles concerned in breathing—the serrated muscles—are also attached to the spinous processes of the dorsal vertebræ as well as to the middle or hinder ribs. Moreover, the great latissimus dorsi muscle is attached to nearly all the spinous processes of the dorsal and lumbar vertebræ, as well as to the scapular cartilage and humerus. When it contracts it carries the fore-limb upwards and forwards. These muscles, therefore, also enter into the composition of the point under consideration.

In our tables we show those sheep that were broad and flat, and without much projecting spine, and withal well covered with flesh as Shropshire. Those that were narrow, flat, with

some projecting spine, and not covered sufficiently to fill in the hollow behind the shoulder-blade, we record as Merino. Many sheep—*i.e.*, 18 out of 72—had to be classed as doubtful, but we did not find any we definitely felt to be composite.

The Loin.

The area from which the butcher cuts the mutton-chop is one second only in importance to the leg of mutton when examining a sheep for value as a meat-producing body.

In the Merino the loin is comparatively narrow, the spines protrude considerably, but not so markedly as is the case with those rising up between the scapulæ "over the shoulder." The flesh lying close up to the spines of the backbone is moderately deep, *but*—and here it greatly differs from the Shropshire—it narrows down at the exterior edge; so that, as the hand passes over the edge of the lumbar region, it is thin. In fact, even the fat Merino or Merino-like sheep does not altogether hide the divisions between the transverse processes that succeed the ribs in the abdominal region.

The loin of the Shropshire is found to be wide and flat (in very fat sheep the flesh even rises up so much as almost to form a groove or depression along the line of the spine), and is also very thick at the edge of the projecting lumbar bones.

The ilio-spinalis muscle, already referred to, enters largely into the composition of this point. The psoas and other muscles forming the roof of the abdominal cavity—*e.g.*, the great psoas which is attached to all the lumbar vertebræ, and usually both to the central portions and to the transverse processes—should also be mentioned.

In our tables we have classed the cross-breds as regards loin in the same way as before.

The Top of Leg.

This point is a very complex one. To be good it must be level—*i.e.*, there must be no falling away, or down, from the line of the back to the tail-head. The width must be great all the way along, slightly wider towards the "hooks" than over the tail, but the lines of the body, at this point, should be as nearly parallel as it is possible to get them. There should be no hollowness or falling in along the line formed from the point of the "hook" (ilium) to the point of the "pin-bone" (ischium). And, again, the length of this line should be as long as possible. Further, all the skeleton of the part should be covered with firm hard flesh, not bony to the touch nor yet lumpy with patches of fat. In every one of these respects the Merino fails;

perhaps most so in the levelness of line from loin to tail-head. All sheep-breeders know how difficult it is to get this point right. Even in the Southdown—possibly, as regards mutton, the most perfect of all sheep in shape—there is a perpetual fight going on, on the part of the breeder, to "keep their tails up." A visit to any of the fat-stock markets in Sussex, where world-famous breeders send their rejected sheep for sale to the butcher, will show any one how frequently this fault is to be found even among these well-bred sheep.

Failure in this point may depend on one or both of two skeletal characteristics. Either the vertebral column in passing backwards may fall towards the ischium, or the ischium may itself drop; moreover, in some individuals it would appear that both of these characters are present. Such is apparently the case in certain of the partly bred Merinos.

The development of the point depends also on the musculature. The muscles applied to the ilium are the gluteal muscles, the superficial and deep gluteus being characteristically well developed in sheep, but varying in different individuals as already indicated. The abductor muscle of the leg (biceps femoris), and the sacro-coccygeal muscles which completely envelop the coccygeal vertebræ, may also be referred to as entering into the composition of this point.

THE RESULTS OBTAINED.

In Table I. we set out the results obtained by the handling of 72 Cross-breds. We took every precaution not to know how each individual sheep was bred when we were handling them. Some (the F 1's) were the offspring of Merinos and Shropshires, others (the F 2's) were the in-bred offspring of Merino-Shropshire crosses.

TABLE I.—72 CROSS-BREDS.

Sheep examined for	Top of Shoulder.	Behind Shoulder.	Loin.	Top of Leg	Total.
Merino-like .	25	27	39	22	113=39·2 %
Shropshire-like .	21	27	17	10	75=26·0 %
Composite . .	8	0	6	23	37=12·8 %
Doubtful . .	18	18	10	17	63=21·8 %

Table showing the distribution of the different kinds of "points" among the 72 cross-bred sheep.

Our next two tables deal with some of the same sheep, only picked out according to how they were bred. The F 1's (Table II.) were the sheep got by the Merino out of the Shropshire.

TABLE II.—28 F 1's.

Sheep examined for	Top of Shoulder.	Behind Shoulder.	Loin.	Top of Leg.	Total.
Merino-like .	8	5	15	7	35=31·2 %
Shropshire-like .	8	13	9	8	38=33·9 %
Composite . .	4	0	1	7	12=10·7 %
Doubtful . .	8	10	3	6	27=24·1 %

Table showing the distribution of the different kinds of points among the crosses of the first generation only (*i.e*, the F 1's).

The third table deals with the F 2's—that is to say, with sheep bred from cross-breds, the animals being the progeny of cross-breds got by the Merino out of the Shropshire.

TABLE III.—44 F 2's.

Sheep examined for	Top of Shoulder.	Behind Shoulder.	Loin.	Top of Leg.	Total
Merino-like	17	22	24	15	78–44·3 %
Shropshire-like .	13	14	8	2	37=21·0 %
Composite . .	4	0	5	16	25=14·2 %
Doubtful . .	10	8	7	11	36=20·3 %

Table showing the distribution of the different kinds of points among the crosses of the second generation (*i.e.*, the F 2's).

Our final table is one showing the percentages in which the different kinds of points occur among the 72 cross-bred sheep (*i.e.*, both the F 1's and the F 2's).

TABLE IV.—PERCENTAGES OF POINTS.

Sheep.	Merino-like.	Shropshire-like.	Composite.	Doubtful
72 Cross-breds .	39·2	26·0	12·8	21·8
28 F 1's . .	31·2	33·9	10·7	24·1
44 F 2's . . .	44·3	21·0	14·2	20·3

The tables show very clearly that segregation of the four mutton points dealt with had taken place among the cross-bred sheep to a marked extent. What is at first sight more remarkable is that this segregation is nearly, if not quite, as apparent in the first generation of crosses (or F 1's) as in the second generation (or F 2's). This phenomenon, however, is intelligible on the otherwise probable assumption that the parent breeds (Merino and Shropshire, either one or both) are not "pure" in the Mendelian sense of the word—that is to say, that the reproductive elements given off by individuals belonging to these breeds are in certain cases the bearers of characters other than those which are typically associated with the breeds in question. The fact that animals belonging to definite breeds frequently produce offspring which fail to conform to the distinctive type is evidence that the varieties in question are not pure, and that the aberrant characteristics have not been entirely bred out. It is reasonable to assume that both the Merino and the Shropshire sheep represent cases of this sort, and a similar statement might probably be made of most of the other breeds of sheep. However this may be, it is clear that, according to the Mendelian theory, one or other at least of the parent breeds employed in our experiments was not pure.

The study of the tables leads us to a further consideration of some practical interest. The Merino in its anatomical and carcase characters is an unimproved sheep, and must be regarded, in these respects at any rate, as far more primitive than the Shropshire or any other improved mutton breed. But since, as has just been shown, these breeds almost certainly carry in a latent or obscured condition characters which belong to unimproved or less improved types, and since the crossing of two different breeds is known to tend towards bringing to the surface latent or primitive characters, we have a possible explanation of the fact that farmers object to the usage of cross-bred stock for breeding purposes. Such animals are

more likely to manifest primitive or unimproved characters, and in a general way, in the present imperfect state of our knowledge, there may be supposed to be less uniformity or a smaller measure of certainty about the points shown by a subsequent generation.

Conclusions.

Our results described above give rise to the following reflections.

There are many breeds of sheep in this country known to possess characters or peculiarities which seem to give them special value. For instance, we visited in the course of one day leading flocks of Shropshire, of Kerry-Hill, and of Welsh-Mountain sheep. The Shropshires may be said to be perfect behind the shoulder, and good over the shoulder and on the top of the leg; the Kerry-Hill unsurpassable for loin; and the reputation of the Welsh-Mountain breed for hardiness is so great as to seem beyond the reach of question, but, from the butcher's point of view, the same perfection does not present itself.

To combine all these perfections in one sheep might well be the ambition of the scientific breeder of a future generation.

But our experience leads us to affirm with little hesitation that there is much to be learnt before any one can hope to start with any prospect of success.

The anatomy of the "points," as we believe this paper sufficiently shows, is so complex as to demand separate work of no mean order. And the question of hardiness is probably one of even greater complexity. The well-known breeder of Welsh sheep, Mr Marshall Dugdale, makes a practice of going to the mountain-top to select the "Boss ram" with which to mate his ewes, and so maintains the constitution or "hardiness" for which the breed is so much valued. But such a system would seem inadequate to the requirements of scientific work. It should not be beyond the reach of the physiologist eventually to determine, with some degree of certainty, why this or another breed is able to withstand hardship and thrive under conditions which are disastrous to other animals of the same species. But all these subjects require skilled investigation, and, moreover, the work is expensive.

There is another matter of some practical importance to which reference has been already made, and which deserves to be further emphasised. Experiments have shown that one of the common results of cross-breeding is to produce types which show little or no apparent affinity to either of the parents, but rather resemble some more or less remote ancestor

to which they are said to revert. This statement would appear to apply more particularly to cases where the two parental breeds are widely different or only distantly related. And since, in the case of sheep, the more primitive characters, speaking generally, are those which are economically inferior, there is a danger that in attempting to create a new variety by cross-breeding, instead of improving our stock, we may induce reversionary changes towards an ancestral type of little commercial value. Moreover, if the crosses are interbred, the undesirable points may be perpetuated. But such considerations are not applicable to cases where the two parental breeds are of closely similar origin (as with two "Heath" breeds), and they will not deter the scientific breeder from utilising the knowledge gained by Mendel's discovery in attempting to combine the favourable features of suitable breeds.

Meantime the practical agriculturist, who does not directly concern himself with experimental research, must be encouraged to take every precaution to maintain the present breeds of sheep in all possible purity. They may not be perfect, from the Mendelian point of view they may not be "pure," but of their kind they are useful, and at present at any rate they are very much the best to be had.

Whether it will ever be possible to improve them further must depend upon the outcome of future investigation. The animal organism is not infinitely plastic; in its capacity for combining characters of economic value there must be a limit set beyond which it cannot go. For the characters which an animal carries in a state of nature are those which are useful to itself, and only in certain instances are these also useful to man. The history of the domestic animals has shown that the "points" to which man attaches value can often be improved and modified, and in certain cases can be united together in fresh combinations so as to give rise to better types. Future research must show whether other and newer combinations which the breeder desires to bring about are incompatible with the wellbeing of the organism, for if this is so, the task becomes a hopeless one, and we are brought reluctantly to realise once more that in this respect the requirements of man must ever be subservient to those of the animal which man has sought to model.

The expenses of the investigation have been largely defrayed by research grants made by the Board of Agriculture and Fisheries out of money allotted to them for this purpose by the Development Commissioners. To these bodies, and to all who have helped us in our investigation, we wish to express our thanks.

HEDGES: THEIR CARE AND MANAGEMENT.

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THERE is no exact information available as to what proportion of the enclosed agricultural land of Scotland is fenced by hedges. Probably wire fences and stone dykes predominate, and their utility in many situations, where the growth of hedges would be impossible, is unquestioned. If the soil and situation are suitable, however, there is no fence equal in value to a well-kept hedge. It is a matter for regret that, on the whole, hedges have been decreasing in the past twenty years or so, and their place taken by wire fencing. This process would seem to be a distinct loss to Scottish agriculture, and if more interest is taken in the future in the maintenance and management of existing hedges, their replacement by wire may yet be arrested.

The origin and history of hedges as a means of enclosure may be traced back in various works on agriculture for a very considerable period. Many references to hedges—more particularly to thorn hedges—are made in the 'Statistical Accounts' which were published at the end of the eighteenth, and the opening years of the nineteenth centuries. That period was one of great energy in agricultural improvement and development, and the numerous volumes of 'Communications to the Board of Agriculture on Subjects relative to Husbandry and Internal Improvement,' contain many articles which may be read with advantage even at the present day. In the second volume of the 'Communications,' published in 1800, there appears a paper by Mr Robert Somerville, of Haddington, entitled "Observations on the Various Modes of Enclosing Land." In this paper, while every kind of fence is fully dealt with, the writer clearly indicates his preference for a good hedge. Referring to the spread of enclosing and improving of land, he says: "The hedges, from circumstances of their being planted at a proper season, the plants made use of adapted to the nature of the soil, and afterwards kept in order by regular weeding and trimming, are of immense value, and form the most beautiful and lasting fences that can be imagined." Mr Somerville farther on refers to neglected hedges, which seem to have been no more uncommon than they are to-day. After describing the correct management of a hedge and the shape in which it should be cut, he proceeds to say: "But in place of this

management, the hedge in most instances, after being planted, is abandoned to its fate, and neither weeding, pruning, nor indeed any other attention bestowed upon it. In that way a number of plants are either choked by weeds or remain in a dwarf stunted state; and such as survive this usage are allowed to shoot up at random, and soon attain a great height without being useful as a fence; and by the spreading of their branches at top not only become naked and open below, but cover three times the space of ground that hedges differently kept usually do."

It would be difficult to describe more clearly or briefly the stages of deterioration through which a neglected hedge passes.

In the 'General View of the Agriculture of the County of Berwick,' written by Mr Robert Kerr of Ayton for the Board of Agriculture, and published in 1809, there are several references to enclosing and fences which give a good idea of the conditions prevailing in the south of Scotland at that time. The writer indicates that some hedges of thorn and beech had been long in existence, and that there had been in recent years a considerable extension of hedges for purposes of enclosure.

Judging from contemporary writings, farm hedges received a fair amount of attention during the first three quarters of the nineteenth century, although probably few new hedges were planted. Agriculture was prosperous and labour sufficiently plentiful. With the last quarter of the century would appear to have come a change, and it is within that period and subsequently that a considerable deterioration of hedges has occurred. From the late 'seventies onwards agriculture had to pass through a severe and prolonged period of depression, resulting in heavy losses to both farmers and landlords, with a corresponding scarcity of money. Labour had to be greatly curtailed, especially on any work which was not absolutely essential to the raising of crops, and hedges and fences undoubtedly suffered neglect in consequence. During the same period there had been a great increase in the number of rabbits in many parts of the country, and where rabbits are numerous good hedges are difficult to maintain and impossible to renew. It is hoped that with the revival in recent years of a measure of prosperity for agriculture, there will be a corresponding revival of interest in the maintenance and improvement of the fixed equipment of the land, of which, next to buildings, fences generally form the most important part.

There are usually two methods of maintaining the fences on farms which are let. The first method is for the whole obligation to be assigned to the tenant. The second method is for the cost of upkeep to be mutually borne by landlord and tenant, one or other doing the work and getting repayment

of half the cost. On large arable farms, such as occur in the east of Scotland, it is not uncommon to find a hedger or spademan specially engaged to keep the fences, ditches, and drains; such men are usually well skilled in their work. It is not possible, however, on the majority of farms to keep a man solely for such work, and the cutting of hedges is often reserved as occupation for the ploughman when the weather does not permit of ordinary farm work being done. Lack of skill and very often unsuitable and blunt tools result in poor workmanship, and hedges kept in this way can usually be identified without much difficulty,

On certain estates it is the practice for the proprietor to maintain all the fences, charging the tenant one-half of the cost. This no doubt involves a certain amount of trouble and book-keeping, but the trouble is well repaid by the results, where the management is systematic and efficient. It is obvious that the men employed under this system must become highly proficient at their work, and attain a knowledge and judgment with regard to the treatment of various classes of hedges such as no casual or part-time hedger has an opportunity of acquiring. This system should also make for economy, as the work is more quickly done, and where good hedges are the rule the expenditure on wire fencing, and paling to fill gaps, is correspondingly reduced. Probably the majority of farmers favour the fences being kept by the proprietor, seeing that they are thereby relieved of a class of work they have no special desire to undertake. The mutually shared cost should also tend to be a check on extravagance, waste, or inefficiency. For the reasons given it seems clear that the management of fences, and especially of hedges, is most efficient and economical if carried out by skilled men on an estate staff, and this system might be introduced on many estates to the mutual advantage of proprietor and tenant.

For the purpose of rating and taxation, the upkeep of fences is considered to be a tenant's obligation. If, therefore, the owner contributes the whole or part of the cost, he is entitled to deduct the amount from the rent actually paid by the tenant when making his return for the Valuation Roll. Alternatively, on estates where a "Maintenance Claim" is lodged under section 96 of the Finance (1909-10) Act, 1910, all expenditure on fencing (less any sums repaid) can be included as a competent outlay. In effect, therefore, it may be said that all expenditure by an owner on fencing upkeep is free of rates and income-tax. This is a point of considerable importance at the present high rate of taxation.

It is not proposed in the space of this article to go into any minute details regarding the formation of new hedges. Full

information on this subject can be got from several text-books, such as 'The Book of the Farm,' Agricultural encyclopædias, or works on Forestry. What is even more important than the formation of new hedges, is the proper management of existing hedges, and it may be safely asserted that for one mistake made in the planting of a hedge, a hundred mistakes are made in the subsequent care and management, or in the lack of care and management. It is therefore with regard to the handling of existing hedges, whether in good or bad order, that this paper is more particularly concerned.

It is perhaps hardly sufficiently realised how cheaply hedges can be maintained if once in good order. Unfortunately, however, the hedge, more than any other type of fence, suffers most quickly from neglect or mismanagement, and once such deterioration has taken place, time, skill, and increased expenditure are necessary to restore the hedge to proper condition.

Owing to the great variation in the size and shape of fields, and the number of roads by which a farm is intersected, it is difficult to give average figures of the cost of upkeep of fences, without such figures differing widely from those which may be obtained in individual instances. The cost of maintaining fences may for these reasons vary widely if estimated per acre, while there might be comparatively little variation if the cost is estimated per mile of fencing. The three following examples are taken from farms varying in size and situation, but in all three instances the fields are mainly enclosed by hedges. The expenditure given includes the upkeep and renewal of gates, and this item will account for 10-15 per cent of the total. In measuring the length of fences, all marches with adjoining farms are counted as one-half. The first example given is a farm where a certain amount of special outlay had to be incurred on fences in one year out of the three, and it consequently shows a higher cost. In each case the expenditure given is a three years' average.

Farm.	Acres	No. of enclosures.	Length of fences Yards.		Total cost of upkeep (3 years' average.)	Cost per acre.	Cost per mile of fence.
			Per acre.	Total.	£ s. d.	s. d.	s. d.
A	311	21	39·2	12,200	22 19 4	1 5·7	65 8
B	115	15	39·6	4,550	4 15 10	0 10·0	37 0
C	209	16	42·5	8,876	11 2 3	1 0·6	50 5

Taking Farm C as a fair average, it will be seen that the cost of maintaining fences is equal to about 1s. per acre and 50s. per mile of fence. It will be observed that the average length of fence required to enclose one acre varies very slightly in the three instances. In the case of Farm B, which should naturally have the highest number of yards per acre enclosed, the

existence of one large rough field has equalised the other small fields. Expressing these results in another form, it may be said that the average cost of fencing upkeep is ·3d. per yard per annum, and allowing 40 yards of fencing per acre, the same result of 1s. per acre is obtained. Comparative figures for wire fencing cannot be given, but it is doubtful whether, allowing for periodical renewals, the cost of maintenance over a series of years would be as low as for hedges.

The selection of species for planting a new hedge is not often a matter of any difficulty. The whitethorn is in most instances, and for most soils and situations, the best hedge plant. It thrives best in a good soil, especially of rather strong texture. The thorn will, however, grow fairly well on loam, and even on light land, although hedges are rather more difficult to maintain in good condition on the latter class of soil. Peat or "black top" land is less suitable for thorn hedges, and the plants are apt to die out on such soil, especially if there is any tendency to sourness or waterlogging. If the peat is thin on "black top" land and lies on clay, thorns may do fairly well once they are established. A thorn hedge does not as a rule thrive close to the sea, probably more owing to salt spray than to high winds. Exposed situations with a strong prevailing wind may spoil the shape of a thorn hedge to some extent, even if carefully kept; but hedges in such situations may nevertheless form useful fences for turning stock.

Beech and hornbeam, which may be classed together for hedging purposes, afford an even closer winter shelter than does whitethorn, and the habit of retaining the dead leaves through the winter months makes a beech hedge look well in any situation. Beech and hornbeam prefer a good soil, and thrive well on either chalk or limestone. They stand drought fairly well, although growing best on land which is normally moist without being waterlogged. Owing to the absence of thorns on the shoots, a beech hedge, if once broken and out of order, is more quickly damaged and penetrated by stock than a whitethorn hedge. The restoration of such a hedge, if once it is neglected and allowed to grow up into trees, is difficult if not impossible. For this reason it is important to keep hedges of beech and hornbeam regularly switched and in good shape.

Where a high and wide hedge is required for shelter or other purposes, beech is especially suitable, and is less liable to become bare and thin in the bottom than whitethorn. Both beech and hornbeam make excellent plantation fences if sufficient space and light are given on the inside next the trees.

The only other hedge plant suitable for agricultural fences is the **Myrobella Plum** (*Prunus myrobalana*). The use of this

species in hedges was at one time strongly advocated, but experience has not altogether confirmed the high expectations originally entertained. Myrobella plum has the advantages that it will grow on rather poor soil, and thrives better near the sea than does the whitethorn. It also has a fairly fast growth. On the other hand, it has a disconcerting habit of sometimes failing in certain situations for no apparent reason. In spite of its quick growth Myrobella plum has a tendency to a thin and straggling habit unless the hedge is cut with care and regularity.

Other plants, such as holly, privet, box, yew, Thuja, and Cupressus, while making excellent ornamental hedges, are unsuitable for agricultural fences.

In dealing with the treatment and management of hedges it may be useful to refer briefly to some of the numerous reasons for deterioration. Among the more common reasons are—

(1) *Neglect to cut at the proper time.*—This fault arises mainly through ignorance and want of a settled policy in dealing with hedges; also, no doubt, from the tendency inherent in many individuals to put off until to-morrow whatever does not call urgently for attention to-day. It is not sufficiently realised that while a hedge which has been regularly switched every year can, in certain cases, be allowed to grow away for two or even three years and then be again cut to shape, there will come a point when the procedure is no longer possible without detriment to the hedge, and special treatment is then demanded. Many men who are good switchers have not the skill or judgment for laying hedges or knowing when this should be done. For this reason overgrown hedges are often wrongly treated before they are ready to lay, or else are left to grow past the time which would be most favourable for laying down. With regard to the date for annual switching, any time from August to the breaking of the bud in spring is suitable, although for preference the period after the fall of the leaf in autumn is the best. Hedges may be considerably damaged by cutting with an unsuitable or blunt knife, and by using a downward instead of an upward stroke. It need perhaps hardly be mentioned that to cut a hedge with shears is very detrimental to the plants, besides being a great waste of time.

(2) *Failure to remove hedge weeds.*—The worst weeds in hedges are the suckers of ash and elm. Elder bushes, briars, ivy, and other plants are sometimes troublesome. Grass and the ordinary field weeds, while detrimental to newly planted hedges, can do little harm in the later stages of growth. It is a common practice when switching hedges merely to cut back elders or elm suckers. Owing to the strong growth of these plants they will, if left in the hedge, gradually spread out and supplant

the hedge plants, whether thorn or beech, eventually forming a weak spot where stock can break through. Some extra trouble is involved in grubbing out these hedge weeds, or in cutting them over at the ground-line and poisoning the roots. Such extra trouble is, however, well repaid in future years by a stronger and better hedge.

(3) *Cutting to a wrong shape.*—This is a common fault, and may be noticed even on estates and farms where the hedges receive regular attention. A square hedge—that is, one with straight sides and a flat top—may be permissible in gardens or policies. Such hedges, especially if of some height, have a very

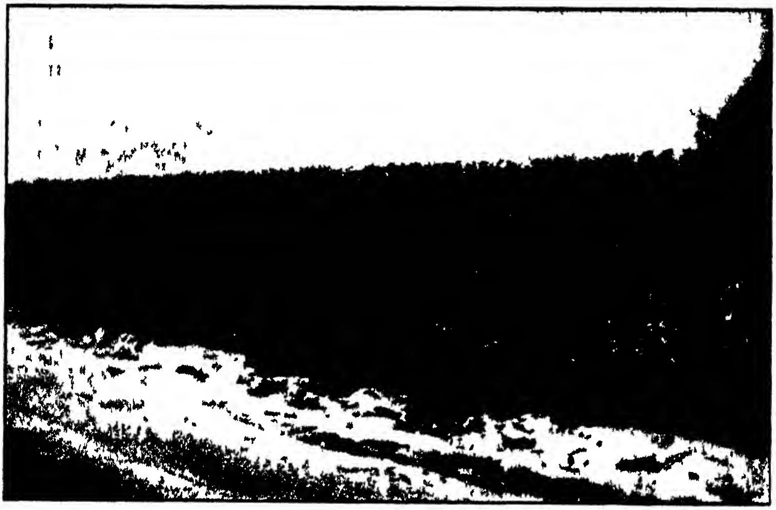

Fig. 1.—*A switched hedge, which has never been laid.*

Note the correct wedge shape and close vigorous growth

ornamental appearance and give good shelter. They are, however, quite unsuited for agricultural enclosures, if only for the reason of the large amount of labour involved in cutting them. Another form of hedge frequently seen is that with a nearly flat but slightly sloping top, and sides which are either perpendicular or actually sloped inwards towards the base. Hedges of this shape have the disadvantage of involving unnecessary labour in switching, and owing to the drip of rain from the upper on to the lower portions of the plant and the want of light for the lower twigs, the bottom of the hedge soon becomes thin. A hedge which has reached this condition allows lambs, or even sheep, to get close in to the roots and to break holes through the hedge. The correct shape for a field

hedge, whether of thorn, beech, or any other species, is that of the triangle or wedge, the thickness at the base being one-third to one-fourth of the height (see Fig. 1). A hedge of this description, if properly attended to, will keep its shape for an indefinite period, and is more easily and expeditiously switched than any other type.

(4) *Switching to the same point over a series of years.*—It is not uncommon to see hedges which are regularly cut get into a weak and unthriving condition due to this cause. No harm arises from switching back to exactly the same point for a few years in succession, but if the practice is too long continued,

Fig. 2 —*A hedge similar to Fig 8, was stripped in hard and all moss scraped off the stems.*

Allowed to grow for a few years and then laid into a switching hedge Has been switched three years

the spurs from which each year's shoots arise become weak and cankered. The twigs are fewer, and lose their vigour to a marked degree. A hedge in this condition should be cut back to a point a few inches behind the old spurs, and if then left unswitched for two seasons the growth will probably regain full vigour. Otherwise the hedge can be allowed to grow away and then be laid (see Fig. 2) In order to prevent a hedge getting into such a condition, the best plan is to switch not quite back to the old spurs. If this is continually done for many years the hedge naturally gets larger; and if in course of time it becomes too high or broad, it can be again cut into shape as above described.

(5) *Waterlogging of hedge roots.*—This is a more common cause of hedges dying out or becoming unthrifty than is sometimes realised. Neither thorn nor beech object to a fair amount of moisture in the soil, but they are intolerant of stagnant water or waterlogging. These conditions usually arise through the neglect of burst drains or from failure to clean adjacent ditches, and newly planted thorn hedges are very quickly affected in this way. It is not uncommon to find old tile drains laid close to and parallel with a hedge, instead of a few yards distant from it. These drains are specially liable to become choked from the roots of the hedge, and main drains crossing hedges often become obstructed from the same cause. Any sign of damage to hedges—especially to young hedges—from this cause should consequently be dealt with as soon as possible.

(6) *Exposure of roots.*—Hedges situated on banks are liable to have their roots exposed, partly from the ordinary effects of weather in crumbling the soil, and partly from the trampling of stock. Where rabbits are present the damage is usually worst, as the soil is scraped away wholesale and the burrows go right below the main roots. No hedge can thrive in these circumstances; and where the thorns are large and the soil light, it is not unusual to see individual stems fall completely over through want of support. If rabbits are killed out of hedges, the exposure of roots from other causes can be easily remedied by taking some soil on either side to complete the covering.

(7) *Damage from hares and rabbits.*—An incidental cause of damage from rabbits has just been referred to; but apart from this the rabbit must be considered one of the worst enemies of hedges, especially thorn hedges. All young growth within reach is systematically peeled or eaten in hard weather, and in a severe snowstorm the damage may extend three feet up from the ground. The formation of new hedges and the laying of old hedges are practically impossible where rabbits are numerous; and even with the utmost care it is difficult to maintain mature hedges sufficiently thick in the bottom. In order to have really good hedges it is essential to exterminate this common enemy of both agriculture and forestry. The damage done by hares, although sometimes considerable, is less serious and of a different character. Hares are exceedingly capricious in their attacks on young growth, and as a rule are much more destructive to beech than to thorns. A single hare may do a great deal of damage by cutting off shoot after shoot in a young hedge, and at the point where hare-runs pass through a hedge the shoots are nearly always cut. On the other hand, some hedges may remain absolutely untouched

even where hares are fairly numerous. Shoots which have been bitten through by a hare do not generally send out a healthy growth the following season, unless pruned with a sharp knife just below the wound. If a young hedge has been badly damaged by hares, it is well worth while going over it for this purpose.

(8) *Damage through driving nails, &c.*—Injury of this description usually represents one of the later stages in the decay of an old and neglected hedge. As the thorns become thinner in the bottom and unable to turn stock, the gaps are filled with brushwood, paling, wire, or odd pieces of wood or iron. The wood or wire is usually nailed on to the thorns. The contact of the nails and wire has a detrimental effect on the live wood, especially in frosty weather, and the driving of nails frequently splits the stems badly. This can be readily seen in any old hedge by examining the nail-holes and the stems which have been rubbed or cut into by wire. Old hedges which are full of nails are much more difficult to lay down if renovation in that way is being attempted.

(9) *Rubbing of stems by cattle or sheep.*—This is another form of injury, which only arises after a hedge has ceased to thrive and has become thin. As soon as the main stems of the hedge-plants become exposed through the dying out of the side branches, these stems become a favourite rubbing-place for stock. The natural grease off the bodies of the animals—more particularly the grease from the wool of the sheep—has a very poisonous effect on the bark, which soon gets into a cankered and dead condition, due to the clogging of the pores of the stem. Apart from the injury to the hedge, there may be a quite considerable loss of wool from the sheep. If a hedge in this state cannot be dealt with immediately, it is desirable to erect a protection fence of some kind to prevent further damage.

(10) *Hedgerow timber.*—The retention of hedgerow timber is a somewhat vexed question. Trees in hedges greatly add to landscape effect, and may also afford useful shade for stock; but unless pruned of branches to a fair height, they are undoubtedly detrimental to good hedges. Beech is the worst species in this respect.

The laying of hedges has been already incidentally referred to, and as this method of treating hedges is little known in Scotland a short description of the process may not be out of place. Hedge-laying may be carried out at any time through the winter after the fall of the leaf, although it is as well to suspend operations in hard frost, as the stems then become brittle. The best time to lay very rough old hedges is in the spring, when the sap is beginning to rise. The stems are

less brittle at that date, and not so likely to break off when partly cut through and laid over. Beech is unsuitable for laying, but a young hornbeam hedge in full vigour will lay satisfactorily,

Hedges suitable for laying must be of a height of from 9 to 12 feet. The best hedge for the purpose is one with numerous well-grown vigorous stems, not exceeding 3 inches diameter at the root. Large rough thorns can also be laid; but as they are generally thin and far apart, every stem is practically required to make a fence. There is not in this case the same opportunity of selection and of cutting out unsuitable growths. Large rough stems are usually brittle

Fig. 3.—*A young hedge planted in 1907, showing the work of laying in operation.*

and cankered, and even with the greatest care and skill a proportion of them will break over when being put down. The most difficult hedge of all to deal with is one which, at some previous time, has been cut over to within 12 or 15 inches of the ground. Such stems are usually black and unsound in the wood near the ground-line, and even when laid they may die out subsequently. When laying a hedge the selected stems are cut about three-fourths through with a light hedge axe, the cut being a long and slanting one. The stem is then bent over until it lies at an angle of about 35° or 40°, on the top of and parallel with the previously laid stem (see Fig. 3). In a young vigorous hedge the laid stems may be as numerous as five to the yard, but with rough old hedges it is often

impossible to get more than two stems to the yard. Stems which are unsuitable for laying, or which are not required, are cut clean off at the ground-line with a slanting cut, so that they have a chance to spring away from the root and help to furnish the young hedge with new growth. All moss growing on the selected stems should be scraped off. This well repays the trouble involved, as it greatly increases the number of fresh shoots. In order to hold the laid stems together and preserve the shape of the hedge, stakes are driven every 18 or 24 inches along the line of hedge, and the laid stems are twisted in and out of the stakes. Occasionally "live" stakes are used by leaving growths in the hedge for the purpose, but on the whole "dead" stakes are preferable. The latter are usually 4 feet 6 inches in length and 1½ to 2 inches diameter at the small end. Excellent stakes for the purpose can be taken out of spruce branchwood when timber is being felled, and these branches if not utilised in this way would probably be burnt with the rubbish. Although not always done, it is very desirable to put a "binder" on the top of a laid hedge. The binder greatly strengthens the fence, and also adds to the neatness of its appearance. The best binders are made from hazel coppice, the rods being 1 to 1½ inch thick at the base, and 8 to 10 feet in length. The rods are twisted round each other like a rope, and at the same time carried in and out of the stakes. If hazel is not available, any other similar rods can be used, such as ash, alder, &c. When first driven the stakes are usually uneven in height, and the hedge is finished by cutting off the tops of the stakes all at one level. The two sides of a laid hedge present an entirely different appearance. On one side is the "brush"—that is, the untrimmed side branches and twigs of the laid stems (see Fig. 4A). The brush is usually quite a sufficient protection for some years against sheep and cattle, although scarcely adequate to keep back horses. On the opposite side, on which the hedger stands when working, the brush is cut away so as to allow the young growth to spring freely (see Fig. 4). In one type of laid hedge the stakes are driven directly in the line of the roots, thus giving an absolutely vertical fence. In the second type the stakes are driven slightly off the line of the roots on the "brush" side. This is the preferable method, for the reason that the young shoots get more light and air to develop. In an east and west hedge it is best if possible to lay the hedge with the "brush" on the north side, so that the growing side may get as much sunlight as possible. In a north and south fence the "brush" is best laid on the side where most shelter is required.

It will be obvious from the foregoing description that the growing side of a laid hedge requires protection against stock

Fig 4.—*An old hedge laid in 1912. Front view showing young shoots with protection fence.*

The stakes and binders are clearly visible.

Fig 4A. *Back view of same hedge.*

The brush is still in position and affords an effective barrier to stock.

for a few years until the young growth is sufficiently strong to take care of itself. There are various methods of protection. One of the simplest, where there are no heavy cattle, is to lay

the thorns which are cut out of the hedge as a dead hedge a few feet out from the growing side of the laid hedge. The butts of the dead thorns are laid in a shallow trench cut for the purpose, and they are kept together and in a vertical position by a single strand of wire, barb or solid. A dead hedge of this description is a very temporary form of protection, and will not last more than two years or so, after which the thorns become brittle and easily broken by stock. Another form of protection is the ordinary five-wire fence, set a sufficient distance from the hedge to prevent horses or cattle reaching over and biting the shoots. A very useful form of protection fence

Fig. 5.—*An old hedge laid in 1915, showing growth in that time (two years).*

The marked variation in growth between different plants, which is characteristic of laid hedges in the first few years, is very distinctly shown.

when the hedge is straight is one of the numerous types of wire-woven fencing. This material has the advantage of requiring fewer stakes than an ordinary wire fence, and after the protection fence has served its purpose, and the hedge is able to look after itself, the wire-woven fence can be rolled up for removal and re-erection elsewhere.

The cost of laying a hedge varies greatly according to the age and condition of the thorns. A skilled hedger will do 25 yards per day on a hedge that is in good order for laying, provided the stakes and binders are laid down for him, and he has not to prepare these as he goes along. An old hedge, in bad condition for laying and requiring particular care, may take rather more time, and 18 to 20 yards per day will repre-

sent the progress made. Allowing for the stakes and binders, 2½d. to 3d. per yard will represent the average cost of laying. To this has to be added the cost of the protection fence, but if this is of wire it may serve in two or three different places, and consequently the whole cost of material need not be charged against one fence.

In hedges where the roots are old and in bad condition it is desirable to assist a laid hedge by planting in some fresh thorns to make up the stock. The object is to secure, when the hedge next comes to be laid, a good selection of stems of suitable size and quality. In the first season after laying, a

Fig. 6.—*A very old hidebound hedge with a lot of briars growing in it.*

These were all taken out before the hedge was laid down in 1909. This hedge has not grown so well as hedge in Fig. 7, but it will do better when laid a second time. Compare the smaller number of shoots and more straggling habit of the twigs with Fig. 7.

very old hedge may not show much signs of growth. In the second season, however, there is usually a great improvement, and strong fresh shoots will be seen springing away not only from the cut-over stems, but also all along the edges of the slanting cuts (see Fig. 5). There may, in an old hedge, be spaces of a few feet here and there where no growth comes away, and these spaces can only be filled when the hedge is laid for the second time (see Fig. 6). In dealing with old overgrown or worn-out hedges, the best policy is to allow them to grow away untouched after laying, except for breasting up on the sides if that should be necessary. Such a hedge will probably be ready for laying a second time in eight or ten years

(see Fig. 7). After being laid a second time the hedge will be well filled up and in excellent order. If intended for the future to be treated as a switching hedge, the growth can be first cut two or three years after laying, and the hedge is gradually worked into correct shape for that purpose. The stakes, brush, and binder sometimes persist for a long time, but gradually fall away.

Where an old hedge has deteriorated to such an extent as to be unfit for laying, the only possible remedy is to cut the thorns to the ground and make up all blanks with fresh plants (see Fig 8). The soil along such hedges is often com-

Fig. 7. *An old hedge laid down in 1906 showing eleven years' growth.*

This hedge is ready for laying a second time The binder and stakes have disappeared, and the protection fence has long ceased to be necessary.

pletely exhausted, and if that is so the young thorns planted in will make little or no growth unless supplied with some fresh soil or with some form of mulch or manure. The treatment of a hedge in this way necessitates a double protection fence, and it will be a matter for consideration in such cases whether it is not preferable to plant an entirely new hedge on fresh soil on one side or the other of the old hedge, the latter with a little repair serving as one of the temporary protection fences, and being eventually grubbed out when no longer required.

The foregoing remarks have been made, so far as possible, to meet the conditions of all those who may have the care of hedges, whether landowners or tenants. For the benefit of those, however, who may contemplate taking up the question

from the estate point of view, a few remarks on administration may not be out of place. It is necessary in the first place to determine upon what terms the maintenance of fences is to be undertaken—that is, what proportion of the cost is to be repaid by the tenant. The customary proportion is one-half for division and roadside fences, and one-fourth for march fences. Plantation fences may be charged at one-half or one-fourth, or in some cases are maintained free of expense to the tenant. It is desirable to include the maintenance of gates in the fencing arrangement. At first sight it may seem that a vast amount of trouble and book-keeping is involved even on a small or

Fig. 8.—*A very old round topped hedge, past switching.*

Was cut down close to the ground and blanks filled up with young thorns in 1905 Allowed to grow for nine years before being laid into a switching hedge, and then given three years growth before switching (Once switched)

moderate-sized estate. This is not really so, and once the work is organised there is no difficulty in keeping the necessary records. It is essential to keep time-sheets for the labour, and these must show the different holdings on which each day's work has been done, and also distinguish between division, march, and plantation fences With regard to material, it is necessary to enter in a book the quantity of wood, wire, &c., and the number of gates issued for the different holdings, whether purchased or obtained from the estate sawmill. If it is desired to include with the wages a sum to cover accident and health insurance, use of tools, &c., this will represent between 2d. and 2½d. per man per day. In making up a statement of the total amount expended at the end of each half-year or year,

and the sums repayable by tenants, it is convenient to show in tabular form for each holding the following particulars of cost: (1) labour; (2) posts, rails, &c.; (3) gates, gateposts, and mountings; (4) wire, nails, staples; (5) stakes and binders for laid hedges; (6) total cost; (7) sum repayable by tenant.

If it is desired to make a calculation as to the number of hedgers required on a given area to maintain the fences, the cost of upkeep referred to in an earlier portion of this paper will give approximate figures. Thus for an estate of 5000 acres an allowance of 1s. per acre is equal to £250; or allowing 40 yards of fencing per acre enclosed, at 3d. per yard, gives the same result. If the fences are almost wholly hedges, the expenditure will be nearly all in the form of labour, and three to four men could find employment. If wire fences are numerous the labour would cost less, but the material considerably more. These figures are based on the assumption that the fences are in good order to start with, and merely require to be maintained. If this is not so, nearly double the expenditure might be necessary for a period of years. The case of large hill farms is of course quite different, and the cost of maintaining fencing on such holdings cannot be averaged with any accuracy.

It is of considerable value, although not essential, to have a fencing book, showing for each holding the length and description of the fences, referring to them by numbers which are entered on the Ordnance Survey sheets or estate plan. Such a record exists on some estates, and is of special value in connection with changes of tenancy, or when special reports on the fencing of a farm are required.

No attempt has been made in this article to lay down hard-and-fast rules for the treatment of hedges, and it would be a mistake to do so. Hedges may be said, in one sense, to have as much individuality and to show as much variation as live stock or farm crops. It is only by observation and experience that the best can be achieved in the management of hedges. Failure to recognise this fact has resulted in many bad hedges at the present day. It is hoped that the foregoing suggestions may serve as general principles for guidance on the subject, and may tend to arouse increased interest in the care and management of hedges.

The writer is indebted to Mr David Crabbe, Byreburnfoot, Canonbie, for selecting the hedges which are illustrated and writing the descriptions. The illustrations are from photographs taken by Mr George Tweddle, Canonbie, who has himself taken part in the work of cutting and laying many of the hedges referred to, and to whom the writer also desires to record his thanks.

MODERN ENSILAGE PRACTICE.

By A. W. OLDERSHAW, B.Sc. (Edin.), N.D.A., Agricultural Organiser for East Suffolk.

ABOUT thirty years ago, partly no doubt owing to a series of exceptionally wet years, much interest was taken amongst our foremost agriculturists in the manufacture of silage. Experiments were carried out by the Royal Agricultural Society of England and by many private individuals.

In the 'Transactions' of the Highland and Agricultural Society of Scotland for 1885, a Report of the Proceedings of the Ensilage Committee, written by Mr Colin J. Mackenzie, is given. Mr Mackenzie conducted a number of experiments with silage at Portmore. He concluded—

(1) That nearly every kind of forage plant, and especially grasses, can be preserved when in a green state; and that when so preserved they form a suitable food for all classes of cattle and sheep.

(2) That grass crops can be preserved at a somewhat less cost than by making into hay, and that the system of ensilage has a further advantage over hay-making—viz., that it is independent of weather.

(3) That certain crops (such as white crops in upland districts in late seasons, aftermath, &c.) can by this process be turned into good fodder; while under the existing system they are frequently damaged and sometimes lost.

(4) That cattle and sheep will thrive as well on silage as on turnips, and that accordingly it will be possible under this system to work in many districts with less cultivation, and consequently with less expense.

(5) That the system is worthy of the best attention of the Society.

In the 'Transactions' of the Highland and Agricultural Society for the same year, Dr Aitken reported on a number of analyses of silage he had made; and in 1887 he stated that he had recently received for analysis several samples of silage made from common bracken.

At the Suffolk Fat Stock Show, held in 1890, prizes were given for ensilage, six samples being exhibited.

After this period a series of dry seasons followed, and interest in the practice gradually died out.

In 1901 Mr F. B. Smith, late of the South-Eastern Agricultural College, Wye, Kent, visited some of the American Colleges where maize silage is so closely associated with winter stock feeding, and discussed the subject in the report[1] on his visit. Subsequently a series of experiments with maize silage were carried out at Wye, in Kent, the conclusion arrived at being that maize silage was not profitable, because, although the maize was grown upon early soil and early varieties were planted, it contained when cut much more moisture than American-grown maize. As a result of this, the losses owing to fermentation reached the very high figure of 30 per cent of the total dry matter.

During the past few years there has been a great revival of interest in the subject in East Anglia. More than forty silos of the modern cylindrical shape have been erected, whilst at the Ipswich Fat Stock Show, Christmas 1916, the writer had the honour of collaborating with Mr G. P. Watkins in judging a class for Ensilage in which there were no less than 23 entries.

This greatly increased interest in the manufacture of ensilage has been largely due to the enthusiasm of Mr G. Jaques of Tivetshall, Norwich, and to the building by Mr F. W. D. Robinson of a concrete silo on his farm at Roos Hall, Beccles, Suffolk.

Modern Ensilage Practice.

The modern system of ensilage differs from that formerly practised in two important ways—

(1) In the type of silo used. Formerly silos of a more or less rectangular shape were used, and it was necessary to apply pressure. Thus Mr Colin J. Mackenzie, in the 'Transactions' previously referred to, states that the silos he erected were 30 feet long, 12 feet wide, and 16 feet deep. He considered that the best silage was made under a heavy weight—say 120 to 150 lb. per superficial foot. The modern silo is cylindrical in shape, and is made so high that no pressure is necessary other than that of the weight of the overlying masses of green material.

(2) Formerly it was usual to make silage of any green material—clover, grass, &c.

It is now recognised that, in order to obtain sufficiently heavy weights of green material per acre to render the system profitable, it is necessary to grow a special crop, such as tares and oats, to make into silage.

[1] 'Agriculture in the New World.' F. B. Smith.

The advantages of making Silage.

The advocates of the silage system claim [1]—

(1) That it produces a large bulk of valuable food at a low cost.

(2) That there is almost a certainty of obtaining a crop.

(3) That the crop can be ensiled in June and July, when the land is dry and the days are long.

(4) That there is no risk of loss from early frost as with mangolds.

(5) That the land is cleared early, and is then made ready for turnips on suitable soils. On the heavier soils mustard can be grown and ploughed in, or a bastard fallow made.

They also claim that a great saving of labour is effected throughout, as compared with roots, and that more stock can be kept on the farm than is possible when roots are grown, consequently that more dung will be available. This, together with the residue of the slag applied to the tares, and the nitrogen accumulated in the soil by that crop, is, they say, sufficient to maintain the soil in a high state of fertility. They also claim that, under the silage system, it will pay to plough up poor grass lands, in this way permanently increasing the home-grown food supply by increasing the area under tillage.

The writer of this article has had an opportunity of observing the results obtained on a large number of farms in East Suffolk where the silage system has been adopted, and has come to the conclusion that there are large areas of land in Great Britain and Ireland where its introduction would be an advantage.

On good soils, where 30 to 40 tons per acre of roots can be grown regularly with ordinary skilled management, it is hardly probable that the silage system presents any advantages over the growing of roots. In fact, on such soils the writer holds that root-growing is a most economical and profitable way of producing food for stock. But it must be remembered that there exists in this country very large areas of land on which the growth of such crops of roots as those above mentioned can only occur in the most favourable seasons and with exceptionally careful management. It must be admitted that many of our soils, particularly the tenacious clays and light sands, are so unsuited to root-growing as to dishearten all but the most skilled and persevering. The writer is in cordial agreement with the contention that it is desirable in the national interest to plough up many of our poor grass lands, and he knows many

[1] See "Silage as a Food for Stock." G. Jaques, 'Journal of the Board of Agriculture for England,' March 1916.

poor heavy clay grass farms, particularly in the Midlands of England, where the introduction of more tillage, coupled with silage, would undoubtedly increase our food supply. If, as the writer confidently anticipates, the silage system proves to be economical on such soils, one of the obstacles (the unprofitable bare fallow) to the extension of the wheat area will have been removed. From a food production point of view it is of the greatest importance to remember that land under tillage produces more food, both for man and beast, than land under grass. A poor clay land field will usually produce at least twice the weight of dry matter per acre under tares and oats that it will under poor grass. This, in the writer's opinion, is the most important argument in favour of ensilage.

There can be little doubt that a heavy crop of oats and tares —the crop most in favour for ensilage purposes—can be grown on most poor heavy soils at very little expense, and with very little risk of failure, provided the seed is well covered. Thus a foul cereal stubble on heavy land, which in the ordinary way would require a bare fallow, can safely be sown with winter oats and tares, and the land cleaned (if the weather proves propitious), after the removal of the crop, by a bastard fallow, in time for wheat again. Such unkindly clays may, it is true, often be cleaned in the month of May, given fine weather; but if this is done, in the Eastern and Midland counties of England at least, in an average season, practically all prospect of obtaining a mangold crop is gone, and the climate and soil are both unsuited for swedes.

On more easily worked soils quite a good crop of white turnips may be grown after the removal of the oats and tares, given a favourable season. In early spring of 1916 the writer weighed a crop of white turnips grown after a silage crop on the farm of Mr C. C. Smith, Walton Hall, Felixstowe, the weight obtained (tops and roots together) being 15 tons per acre.

An equally good crop of turnips was obtained in the same year, after oats and tares grown for silage, by Mr John Oldrin of Rushmere, Lowestoft. In the present year, 1916-17, turnips sown after a silage crop have usually been much less satisfactory.

Summarising, the writer would point out that on good soils a good silage crop will produce far less digestible dry matter per acre than a good crop of roots. On poor soils, however, either very light or very heavy, where roots are very uncertain, the silage system possesses many advantages.

On poor land, now under grass, the writer considers that the introduction of more tillage, in conjunction with silage, bastard fallows, steam cultivation and wheat, would materially increase

our home-grown food supply, and hence be of permanent benefit to the nation.

In view of these modern developments of ensilage practice, it was thought that a short article on the subject would be of interest to Scottish farmers.

Most suitable Crops for Ensilage.

So far as is at present known, the most suitable crop for silage, under English conditions, appears to be a mixture of winter oats and tares. Rye, when mixed with tares, is apt to get too forward and to make rather woody silage. At the period about thirty years ago, when silage created so much interest, it was not so usual to grow special silage crops, grass being chiefly used for the purpose. Oats and tares, however, possess the great advantage of growing luxuriantly on poor land, and also of growing—at least under East Anglian conditions—a much greater weight of green stuff per acre than either grass or clover. The writer has found that 14 tons of green oats and tares can easily be grown,[1] whereas 8 tons of green clover is quite a good crop. In East Anglia lucerne and maize are also used for silage making. For Scottish conditions, in all probability spring-sown oats and tares will prove satisfactory on most soils.

Being a leguminous crop, tares can obtain a large proportion of their nitrogenous plant food from the air by means of their root nodules, and they require little or no nitrogenous manure. A liberal supply of phosphatic manure—basic slag or superphosphate—will be all that is required on most heavy soils. On light soil the addition of potash to the phosphate may be desirable. By accumulating nitrogen, the tare crop increases the stock of this manurial ingredient on the farm. Tares are easy to grow and failures are comparatively rare. In this respect they compare favourably with roots, which in East Anglia are very uncertain, particularly on heavy clays and light sands.

Of the twenty-three samples of ensilage exhibited at Ipswich Fat Stock Show, 1916, seven consisted of oats and tares only; three of oats, tares, and wheat; one of oats, tares, and rye; another of oats, tares, rye, and beans. Two samples were made from green maize; five from clover alone, or a seeds mixture; whilst one sample was made from meadow-grass, and one from a mixture of tares and clover. In the remaining cases the composition of the mixture used was not stated. It will thus

[1] See article on "Cost of Production of Silage"—Amos and Oldershaw—'Journal of the Board of Agriculture,' July 1916.

be seen that oats and tares formed the basis of the mixture in twelve cases out of twenty-three. The object of including a few beans in the mixture is to make the crop stand up and so lessen the labour of cutting. Experiments are wanting as to the most suitable mixture to use, but on the whole the writer would favour two bushels of tares and one bushel of oats per acre. If there is fear of the crop being so badly laid as to render cutting very difficult, half a bushel of beans might be substituted for half a bushel of the tares.

On very poor land the writer has evidence which leads him to believe that the crop obtained by sowing tares alone is greater than when a cereal is included. This is no doubt due to the fact that the leguminous crop is independent of the stores of nitrogen in the soil.

On a poor heavy land farm near Saxmundham, Suffolk, in 1916, tares alone gave 11 tons 15 cwt. of green material per acre, whilst tares and rye mixed gave only 7 tons 5 cwt.

There is every reason to believe that tares alone would make excellent silage, and the only objection to growing them would be difficulty in cutting.

In this connection it is worthy of note that in the 'Transactions' of this Society for 1889, it is stated by Dr Aitken that Colonel Innes of Learney recommended that tares for silage should not be mixed with oats, as he had found that sheep fed on the silage rejected the oat stems. He obtained a heavier crop of tares alone than of tares and oats.

Mr John Speir, in the 'Transactions' of the Society for 1890, page 101, gives much valuable information on the cultivation of the vetch or tare crop. He recommends that when vetches are to be made into silage, they should be cut a little earlier than when made into hay. There is much diversity of opinion in East Anglia as to the right time to cut vetches for silage; but the writer has formed the opinion that it is best to cut them before the pods form, because the plant is then much less woody. It also frequently happens that vetches will stand up fairly well until the pods begin to form, when a single storm may throw them down and greatly increase the difficulties of cutting. Materials which are very moist can be successfully made into ensilage by mixing with dry chaffed oat-straw. Thus on the farm of Mr F. W. D. Robinson of Roos Hall, Beccles, Suffolk, ensilage was successfully made in 1915 from a mixture of green mustard, tares, and oat-straw. Good results have also been obtained on the same farm from a mixture of chaffed green stuff and damaged dry hay.

In this connection it is worthy of note that Dr Aitken, in

his report above mentioned, points out that bracken silage contains a large amount of albumin. He suggests that the bracken be cut when young and juicy, and before the curl has gone out of the leaf. He also states that when bracken silage is well made, stock eat it readily and thrive upon it.

The writer, during the past season, endeavoured to arrange to have this matter tested in a modern silo, but owing to scarcity of labour it was not found possible to carry the experiment through. It is, however, a point of some interest in districts where bracken thrives.

Dr Aitken gives the analyses of two samples of bracken ensilage sent to him. They contained 26·41 and 27·25 per cent of dry matter respectively.

Grandeau, in the 'Journal d'Agriculture Bratigue,' 1893, vol. ii. p. 742, confirms the conclusions reached by Dr Aitken. He states that stock which refused green bracken consumed the ensiled bracken greedily. The writer has no experience of bracken ensilage.

Methods of manufacturing Silage.

It is practically common knowledge that sweet silage can be successfully manufactured from grass, in clamp-like heaps, the whole being covered with soil, like a manure heap, the only permanent weight applied being that of the soil. The heap should be consolidated by carting over it with the empty carts at the time of building. This method of manufacture, as far as the personal observation of the writer goes, results in a sweet silage with a pleasant smell, the whole somewhat resembling tobacco in appearance. No special apparatus is necessary; but considerable waste takes place on the sides, top, and bottom of the heap. The writer has seen this method applied very successfully to chaffed grass—chiefly in Ireland—but has never seen it tried with clover or tares. Probably the latter material in particular would be too open in character unless chaffed.

Silage may also be successfully manufactured in gravel pits or holes. Thus on the Ringsfield farms of Mr F. W. D. Robinson, J.P., near Beccles, Suffolk, the sides and openings of gravel pits have been barricaded with wood, and the pits filled with chaffed green material to a depth of 15 feet. The material was then covered up with nettles and other waste stuff, weighted with planks of wood and stones, and finally covered up with earth. The silage resulting was of a moderately sour type but quite satisfactory. Considerable waste, however, took place on the sides and entrance to the pit.

Modern Methods of Manufacture.

The disadvantage of the methods above alluded to is that they involve so much waste. East Anglian farmers have therefore adopted the American device of erecting a cylindrical silo, 30 feet or so in height, and about 16 feet in diameter. In silos of this type, it is unnecessary to weight the material, as the weight of the overlying mass provides sufficient pressure.

The silage material is chaffed by a special combined chaffer and blower, blown through the opening at the top of the silo, and allowed to fall at the feet of the man inside. This process goes on until the silo is full. After some time it settles considerably, and may be filled up again with any material handy later in the season, such as second crop of clover. When filling the silo the material is usually guided through a tube inside to wherever it is wanted. The man inside tramples round the outsides,—the middle requires much less trampling. It is an advantage to put some waste material, such as nettles, at the top of the silo, as the top foot or so of silage is always more or less damaged.

The Chaffer and Blower used by most East Anglian farmers is an American make (The Ohio). There is apparently no suitable machine of British manufacture on the market. A strong blast conveys the chaffed material up the tube, which is about a foot in diameter. There is no very obvious reason why other means of elevating the material should not be used if such were available. The chaffer and blower may, however, be used for other purposes, such as chaffing litter, &c.

The cost of this combined cutter and blower was, in April 1914, about £35. The price has now increased to £50 or more. It is driven by an ordinary traction engine.

Cost of Production of Ensilage.

Mr Arthur Amos, M.A., conducted, in collaboration with the writer, an inquiry into the cost of production of ensilage in East Anglia, and the results of the inquiry are given in the 'Journal of the Board of Agriculture' for July 1916.

From a number of weights of green crop taken, it was concluded that an average crop of oats and tares will vary from 10 to 12 tons per acre, and that well-manured crops on good land may produce as much as 14 to 15 tons per acre, and perhaps more. At the present time, owing to war conditions, costs of production vary rapidly. At the time the article

above referred to was written, the following figures were obtained :—

	Field No. 1. s. d.	Field No. 2. s. d.	Field No. 3. s. d.
Cost per ton of green stuff for capital charges (cost of silo, cutter, repairs and interest on capital) . . .	2 1	2 1	1 8
Cost per ton of producing crop (rent cultivations, manure, &c.) . .	5 4	6 8	6 11
Cost per ton of cutting crop and filling into silo	2 8	2 8	3 3
Total cost per ton of crop as filled into silo	10 1	11 5	11 10

If it is assumed that the normal loss of dry matter in the silo, owing to fermentation, oozing out of liquid, &c., is 15 per cent of the total, then the cost of the silage as taken from the silo will be 13s. 6d. to 14s. per ton. Farmers who have not seen the operation will be interested to know that, on the farm under observation by the writer, half a day's cutting with the grass-mower supplied sufficient cut crop for a whole day's filling into the silo. Two horses and one man were required for cutting the crop, but it was necessary to employ in addition four men to follow the mowing machine and clear the cut crop from the machine—as the crop was a heavy one. With smaller crops this is not necessary. Two men were wanted all day for pitching, two men and three horses for driving, loading and unloading (the field was immediately adjoining the silo), two for feeding the cutter and blower, one for treading inside the silo, and one for driving the engine. Part time for a foreman was also allowed. The men employed in cutting the crop and pulling it away from the machine were of course only employed for half the day. Hire of engine and coal was placed at £1, 7s. 6d. a day. It took six and a quarter days to fill the silo, and it was estimated that 24½ tons of green material were put in daily. It is evident that a considerable gang of men is necessary for the operation, and that on small farms a certain amount of co-operation is necessary, as in the case of threshing corn.

The Silo.

There are two main types of silo in Suffolk, both of cylindrical shape and similar cubic contents, the difference being that one type is constructed of wood and the other of reinforced concrete.

Concrete Silos.

These have been built on the general lines advocated by Mr Digby Hussey de Burgh, Drumkeen, Pallas Green, co. Limerick.[1]

[1] See his work on the subject, published by Mansell & Co., Dublin.

The first concrete silo to be built in Suffolk, as far as the writer is aware, was erected on the farm of Mr F. W. D. Robinson of Roos Hall, Beccles It is 25 feet internal diameter and 36 feet high. On the basis of one cubic foot of silage,

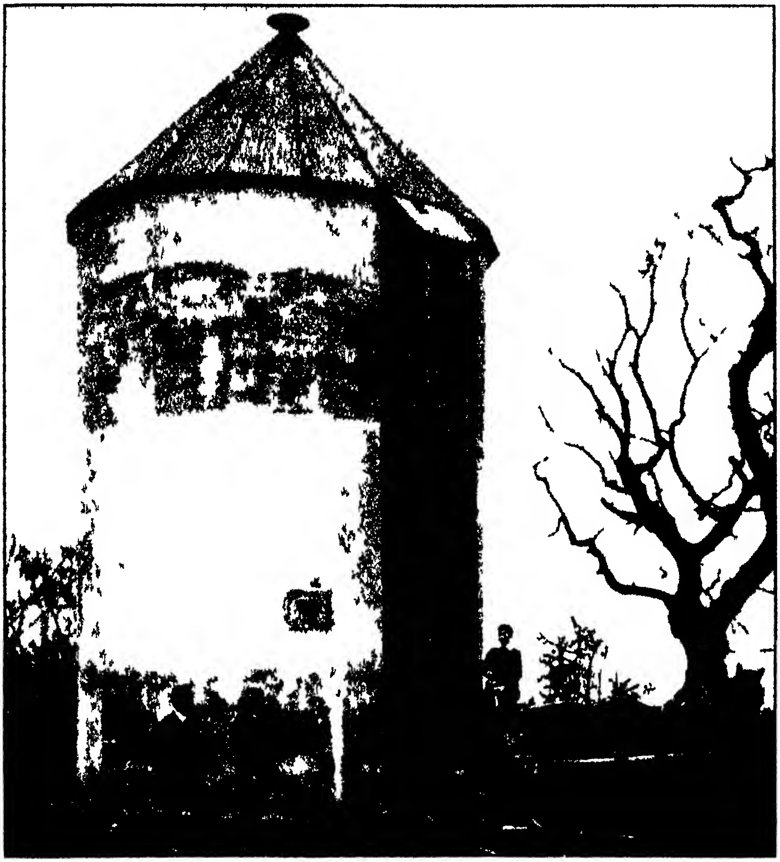

Fig 9 *Modern concrete silo*

The doorways are hidden by the wooden chute The three sets of rings to which the tube of the blower is attached are just visible on the left hand side of the silo

weighing 56 lb., and allowing for 30 feet of solid silage (6 feet for settling), this silo would hold 368 tons

Mr Robinson's silo was of the nature of an experiment. It makes excellent silage, but is rather too large for ordinary purposes, unless a very large head of stock is kept—as is the case at Roos Hall. After Mr Robinson's silo was erected, several farmers near followed suit, and a short description of

one of them, which appears to be of a very serviceable size, may not be out of place here.

Silo on the Farm of Mr Sam Balls,[1] *Carlton Colville Hall, Lowestoft.*

The silo is cylindrical in shape, 15 feet internal diameter, 25 feet high above ground, and 5 feet below. It would have been better 5 feet higher. The concrete walls are 1 foot thick. The silo is washed inside and out with cement. The material used included—

45 loads of gravel, purchased at 2s. a load.
10 loads of sharp sand, purchased at 2s. a load.
12 tons of cement.

The circular mould for fixing the concrete was made by a local carpenter of creosoted wood for Mr John Oldrin of Rushmere, Lowestoft (who had previously erected a silo), and lent by Mr Oldrin to Mr Balls. The depth of the mould is 2 feet 9 inches, so that, allowing for a piece lapping over old work, 1 foot 10 inches deep of concrete can be fixed in a day. The cost of the mould was £7, 10s. Once made, however, it can be used for a large number of silos. The concrete walls of Mr Ball's silo were reinforced with old iron, an old stack bottom and a disused drag rake being used for the purpose. About 2 cwt. of old barbed wire was also used. An exact account of the cost of building was kept, and it amounted to £112, the silo being erected in 1915. The sum mentioned, however, did not include carting gravel, which was done by Mr Ball's own men in slack times. If the carting had been done by a contractor, the total cost of the silo would have been £120. There are five doors in the silo, the openings being 2 feet 6 inches by 3 feet. They are arranged one above the other like windows. A perpendicular wooden staircase is placed outside the silo, with movable steps opposite each door, the staircase being bolted up to the wall of the silo. The wooden doors fit in a ledge, and are kept in their places by the inside pressure of the silage. As soon as the silage is taken out they fall inwards. The doorways serve for the removal of the silage during winter. A wooden chute (wood of 1¼ inch thickness) is arranged over the doors to guide the silage into a cart, which can be backed up below. This prevents trouble from the wind blowing the chaffed silage about at the time of emptying. It also makes the ascent up the perpendicular staircase less dangerous to the men. There is a glass roof to the chute to admit light. The tube of the

[1] The writer wishes to express his indebtedness to Mr Balls for furnishing him with the details given.

blower is admitted through the roof of the silo by means of a small door. The tube is held in position by iron rings, which have been fixed in the concrete walls of the silo.

Wooden Silos.

Within the last few years a number of wooden stave silos have been erected in East Anglia, a firm of timber merchants

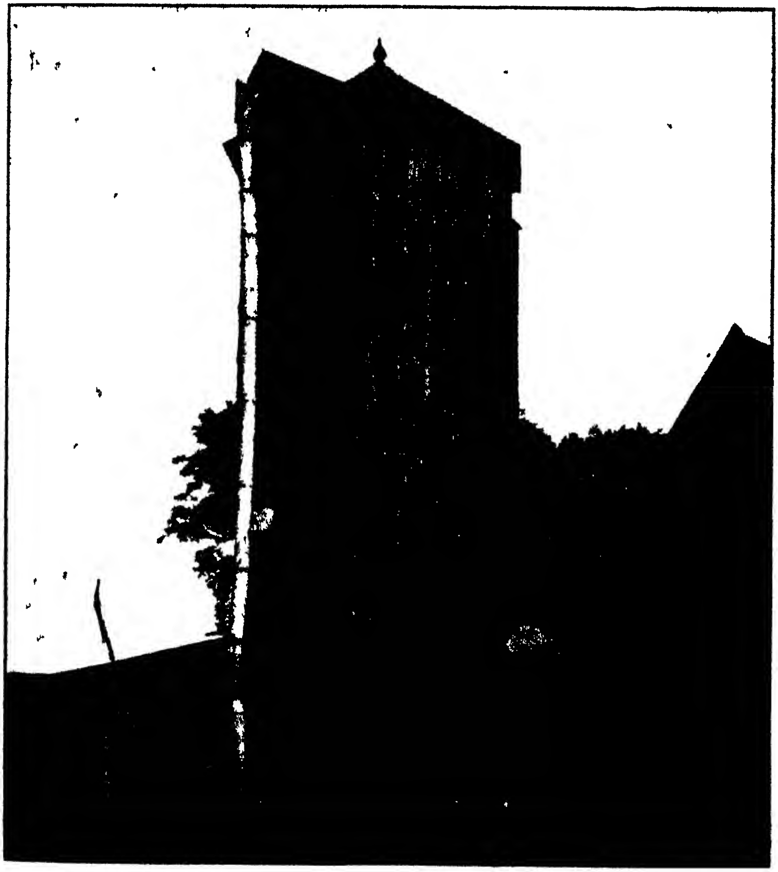

Fig. 10 —*Modern stave silo.*

The Society is indebted to Messrs Jewson & Sons, Norwich, for the use of the photograph from which this print was prepared

in Norwich having specialised in the erection of this type of silo. They are usually 16 feet internal diameter and 32 feet high, the foundation being of concrete. A stave silo is made

somewhat on the principle of a huge barrel, except that the sides are perpendicular instead of bulging out as in the case of a barrel. The whole structure is cylindrical, the staves being bound round with iron bands at intervals. These bands can be tightened up when required.

Three or more wire cables, each attached to a post several yards away from the foot of the silo, serve to anchor the structure and hold it in place, the cables being fastened to the silo near the top. Although the whole is somewhat flimsy in character, the writer is not aware of any silo of this type having collapsed, although more than forty have been erected in East Anglia lately. As in the case of concrete silos, doors are arranged in the side of the silo, one above the other from the ground to the roof, each door being large enough to admit the body of a man. In some cases a wooden chute is arranged to guide the silage down, whilst in others bags are arranged for the purpose Each door is usually held in its place by a screwing-up arrangement. A bar across the door serves as the rung of a ladder, to enable workmen to climb up to the top of the silo. The cost of this size and type of silo has varied from £100 before the war to about £160 in January 1917. The chief objection to these silos is their apparently temporary character. The chief advantage is that they can be removed, and hence are suited for erection by a tenant farmer.

Fig. 11.—*Print showing means of ascending a modern stave silo.*

This silo is being emptied from one of the doors, the opening of which is hidden by the chute. One hand of the man in the print is grasping a stave which goes across the centre of a doorway, whilst his feet rest on a stave across the centre of another.

As regards durability, the oldest silo of this type in this country was erected only four or five years ago, so that we have no information on the subject from British sources. It is stated in Bulletin No. 200 of Colorado Agricultural College,

that in America the life of the stave silo varies from five to twenty years, according to quality of material used, method of construction, and the care and attention given to the silo.

Comparison between Concrete and Wooden Silos.

To compare the two main types of silos three important points must be considered.

(1) *Quality of the Silage made.*—From observations made of silage from the two types, it does not appear, if the same material is used in filling the silo, that one type of silo is superior to the other type, as far as the main bulk of the silage is concerned. It has sometimes been thought that the acid of the silage attacks the cement of the concrete, but this has not been the case in the writer's experience. It has also been thought that concrete might conduct the heat away too rapidly when the silage is being made, but as far as the writer's experience goes, this does not appear to be the case. A former recorder of the East Anglian Milk-Recording Society, Mr F. F. Frost (now farm bailiff at the County Council farm near Northampton), in the course of his rounds had an opportunity of frequently inspecting the silage from both wooden and concrete silos of members of the Society. He formed the opinion that there was more damaged material round the outsides of wooden than of concrete silos—probably owing to the comparative ease with which air finds its way through the walls of wooden silos.

Cost.—Owing, no doubt, to the high price of timber, the cost of the two types of silos does not appear to greatly differ. The cost of concrete silos will largely depend upon the ease with which suitable gravel and sand can be obtained.

Durability.—The writer has formed the very decided opinion that concrete silos will prove more durable than wooden ones. Bulletin No. 200 (August 1914), issued by the Colorado Agricultural College, states: "There have been failures in all types of silos, but it is safe to say that the percentage of failures is less in concrete than in most other types."

The fact that wooden silos are removable, and hence more suited to erection by tenant farmers, has no doubt been an important factor in influencing such farmers in their favour.

Concrete silos are essentially suitable for erection by landlords. Up to the present they have usually been erected by the farmer or landowner himself, with the assistance of a local bricklayer. No doubt the durability of concrete, as of wooden silos, will depend upon the quality of the material used and the method of construction. It may be mentioned that up to the present the writer is not aware that any of the concrete silos erected in East Suffolk have shown any signs of cracking.

Feeding Value of Ensilage.

The experience of the considerable number of farmers who have adopted the silage system in East Anglia has established beyond a doubt that ensilage made under modern conditions is quite a suitable food for stock. As previously mentioned, there are now more than forty silos in East Anglia, and no case has come before the writer's notice in which the ensilage was found to give adverse results when fed to stock.

The writer knows of a number of cases in which cattle fed upon silage alone have thriven well. Thus, in the winter of 1915-16, a large number of young store cattle on the Ringsfield farms of Mr F. W. D. Robinson, J.P., Roos Hall, Beccles, received practically nothing but silage. On most farms, however, it will usually be convenient to feed silage along with other foods, such as hay, straw, roots, and concentrated foods.

Mr Colin J. Mackenzie, in the 'Transactions' for 1885, previously referred to, gives an account of an experiment with store cattle. In this experiment a daily ration of 28 lb. silage (clover and ryegrass) with cake was contrasted with a ration of 30 lb. Aberdeen yellow turnips and 14 lb. of straw, also with cake. The silage-fed animals gave rather better results than the root- and straw-fed animals. During the period of experiment, February 14th to June 17th, they gained an average of 21 lb. a head live weight more than those fed on roots and straw. When subsequently killed, in August—after a summer on grass—the silage-fed cattle had an average carcase weight of 2 st. 11 lb. more than the root-fed cattle, there being a higher percentage of carcase weight with the silage than with the root fed cattle.

Mr Mackenzie also fed silage to lambing ewes with quite satisfactory results.

Mr John Speir, in the 'Transactions' of the Highland and Agricultural Society for 1889, gives an account of an experiment he conducted with silage *versus* hay as a food for milking-cows. In this experiment, part of a field of ryegrass and a little clover was made into first-class hay, and part into silage. According to the analysis of each, the total dry matter fed in the hay was 15·3 per cent more than that given in the silage. The milk given by the cows was slightly in favour of the silage, but the difference was so small as to be almost negligible. The silage had no adverse effect upon the milk.

Mr Speir concludes from this experiment—

(1) That for home use, grass may either be made into hay or silage, without any material gain to either system, if suitable weather be got for each.

(2) That the natural water in silage does not appear to be so much more valuable than the same quantity of water added to dry hay as most people are apt to suppose.

(3) That this latter subject might advantageously be further experimented with by those having the time, convenience, and inclination to do so.

It is worthy of note that when fed with care, ensilage made as previously described does not appear to impart an offensive odour to the milk of cows fed upon it.

This matter was carefully tested in an experiment conducted by the writer early in 1916, and particulars of which were published in the 'Journal of the Board of Agriculture,' June 1916.

The silage-fed cows received 60 lb. silage, 4 lb. dried grains, 2 lb. ground-nut cake, and 7 lb. oat-straw chaff. No offensive odour or other abnormality was noted in any of the milk produced during the whole period of the experiment.

Three members of the East Anglian Milk-Recording Society (Ipswich Branch) have fed their cows largely upon silage during the winters 1915-16 and 1916-17. These herds are under the regular inspection of a milk recorder, and no instance has been observed in which an offensive odour has occurred.

Composite samples of the morning and evening milks have been taken on a number of occasions. The average of nine samples of morning's milk taken from these herds—the cows being of mixed breeds with a large proportion of Holstein—gave 3·1 per cent of butter fat, whilst an average of nine samples of afternoon's milk gave 3·6 per cent of butter fat. Two samples of morning's milk gave 2·9 per cent of fat, all the other samples being above the 3 per cent standard. It does not appear likely, therefore, that silage adversely affects the percentage of fat in milk.

In the experiment above referred to, published in the Board of Agriculture's 'Journal' for June 1916, the writer tested 60 lb. of silage made from oats and tares against 60 lb. of mangolds with 7 lb. chaffed straw, both lots of cows receiving in addition the same quantities of concentrated foods, hay, and straw. In order to, as far as possible, neutralise differences in the milk-yielding capacity of the cows, the foods were changed over in the middle of the experiment, the cows which first received roots and straw now receiving silage and *vice versâ*. At the end of the experiment it was found that the silage had yielded 7914 lb. of milk, and the mangolds and chaff 7811 lb.—a difference of only about ten gallons. This difference may be regarded as almost negligible.

A copy of an analysis of this silage is given below (sample 2).

It is interesting to note that in an inquiry as to the cost of milk production conducted by the East Anglian Milk Record Society during the winter 1916-17, the herd which produced milk at the lowest cost, of those reported on, was partly fed upon silage. The writer of this article, who acts as Hon.

Secretary to the Society, sent an account of the results obtained to the press, and they appeared in the 'East Anglian Daily Times' of Dec. 30, 1916. The herd in question consisted of Holstein cows. The daily ration was 37 lb. mangolds, 50 lb. silage, 2½ lb. dried grains, 2 lb. ground-nut cake, and 2 lb. ground oats. The cows gave an average yield of a little over 3 gallons daily. The report states that in this herd the concentrated foods are systematically varied according to the milk the cows are giving. Thus cows giving 3½ to 5 gallons of milk get 3 lb. cake, 5 lb. grains, and 2 lb. ground oats. Those giving 2½ gallons get 3 lb. cake, 2 lb. grains, and 2 lb. oats. Those giving 1½ gallon get 2 lb. oats and 2 lb. grains, whilst those giving less than this get silage only.

The scientific method of feeding adopted—that of varying the food with the milk-yield of the cows—coupled with the fact that the cows are of exceptionally heavy milking strain, was undoubtedly a potent factor in keeping the cost of production of milk at a low figure in this herd.

The following analyses of silage made under modern conditions have been performed by Mr G. S. Robertson, M.Sc., and are published by his kind permission:—

	Oats and tares.[1]	Oats and tares.[2]	Mustard, tares, and chopped oat-straw.[3]	Tares, oats, rye, and a little wheat.[4]	Green maize.[5]	Clover and rye-grass.[6]
Moisture . . .	67·44	72·30	77·93	69·13	84·85	59·62
Oil	1·15	1·11	0·97	0·81	0·57	2·02
Albuminoids . .	3·84	4·96	3·09	3·17	2·19	6·25
Soluble carbohydrates	15·21	9·75	6·47	11·05	6·31	19·68
Fibre . . .	10·60	9·43	9·02	13·29	4·18	9·79
Ash	1·76	2·42	2·52	2·22	1·60	2·04
	100·00	100·00	100·00	100·00	100·00	100·00
Food units . .	26·69	23·78	15·9	20·27	12·66	38·70

[1] Made in a cylindrical silo on the farm of H. Fiske, Esq., Bramford, Ipswich.

[2] Made in a cylindrical silo on the farm of C. C. Smith, Esq., Walton Hall, Felixstowe.

[3] Made in a gravel pit on the farm of F. W. D. Robinson, Esq., Roos Hall, Beccles, Suffolk.

[4] Made in a cylindrical silo on the farm of F. W. D. Robinson, Esq., Roos Hall, Beccles.

[5] Made in a cylindrical silo on the farm of Fred Smith, Esq., Woodbridge.

[6] Made in a cylindrical silo on the farm of S. Balls, Esq., Carlton Colville, Lowestoft. The moisture in this sample is low, and this accounts for the comparatively high amounts of the other constituents.

The difference in composition of the above samples is undoubtedly in the main due to the different materials with which the silos were filled.

When filling Mr Robinson's silo (sample 4) the weather was exceptionally wet, but the work went on as long as it was sufficiently fine to enable the men to work out of doors.

Prospects of Silage under Scottish Conditions.[1]

Winter tares and oats may be grown in the earliest and mildest districts of the south and east of Scotland. Mr John Speir, in the 'Transactions' of the Highland and Agricultural Society, 1890, pages 70, 74, and 108, gives much valuable information on this subject and on forage crops generally. He speaks of growing potatoes (boxed before planting) successfully after winter oats and vetches, planting the potatoes as late as July 10.

Taking the whole of Scotland, spring tares or vetches mixed with oats and a few beans—say 2½ bushels tares, ½ bushel oats, and ⅛ to ¼ bushel of beans--would probably succeed fairly well in almost any district or season. They would, on the whole, be the crop most likely to succeed for silage purposes in Scotland. The Scottish climate is not suited for making this crop into hay, but a big crop could easily be grown and made into silage.

Second-crop clover and ryegrass would also be very likely to prove useful for ensilage purposes. A silo would enable such crops to be saved without any of the risk incidental to making them into hay. By dressing second crops of ryegrass with a nitrogenous manure, a large crop can be obtained which also might very well be made into silage. In certain late districts late crops of oats which failed to ripen might be ensiled, and so the crop prevented from being wasted. When a silo is specially built, however, a crop must be grown specifically for it, and probably in most cases the spring-sown tare mixture will be found best.

It is worthy of note that a silo which is partly filled in July and allowed to settle could, at the end of September, be filled up with any material that might be available. In the drier and better districts of Scotland, where heavy crops of roots can be grown, it seems improbable that the introduction of silage will displace roots to any great extent. On poor land, both heavy and light—as is the case in England—silage possesses certain advantages.

In the wetter and later districts silage might prove very

[1] The writer wishes to acknowledge the very kind advice of Mr David Black, J.P., of Bacton, Stowmarket, Suffolk, in connection with the above application of silage practice to Scottish conditions.

useful, probably as much as a substitute for hay as for roots. It would certainly render possible the preservation of such a bulky crop as tares, which in many districts is otherwise impracticable. It seems likely to the writer that the introduction of silage would help in increasing the area under tillage. As has been previously pointed out, it would greatly help in the management of the stiff clays, which are so difficult a problem, and which have been so largely allowed to go down to grass. The silage system also might lead to the reclamation of some of our derelict sandy heathlands. The introduction of the vigorous-growing leguminous crop, vetches, on poor land, either heavy or light, is of great agricultural importance, as the land is thereby enriched in the nitrogen which it so sorely needs.

In many districts a change from poor pasture to silage crops, corn, and potatoes, if at all practicable, is unquestionably sound from a national point of view. It would result in a larger production per acre of food, both for man and beast. It would render our country more self-supporting and less dependent upon foreign imports. It would help to solve the problem which, above all others, looms large in the mind of every patriotic British farmer at the present time.

THE BREEDING AND MANAGEMENT OF PIGS.

By WILLIAM BRUCE, B.Sc., Edinburgh.

WHY pig-keeping remains comparatively a neglected branch of animal husbandry in Great Britain, and especially in Scotland, is a subject that has attracted much attention in recent years, and no small amount of argument has been used, both on the platform and in the press, in support of its claims, particularly as a branch of farming. Our great consumption of pig flesh, and our diminishing importation of bacon from America, have frequently been quoted to indicate the opportunity of the home producer; and ample evidence has been put forward to prove that the demand for this article of food has undergone great expansion, and offers good prospects of still further development. The higher standard of living amongst the toiling classes has made bacon and eggs no longer a rarity on the working man's table, and the growing popularity of sausage meat also points to the certainty of a future market.

Why then, we may ask, with such prospects before him, has the British farmer, who has shown considerable genius for handling farm live stock, stood aloof from the pig? It has been demonstrated by experiments that, from the producer's point of view, pig-keeping is profitable. Indeed, it has been shown that among farm animals the pig is the most economical producer of flesh. But notwithstanding all this, pig-keeping makes little or no progress in this country, and it is not uncommon to find farms on which the pig is not even represented; and those on which any special attention is given to it, such as cattle and sheep receive, are exceedingly rare. We believe that the chief reason for this lack of development in a profitable and promising line is, in the first instance, a sentimental one. There appears to be an unwarranted prejudice against swine, and there are still many who can see no beauty in a well-bred pig. But the greatest hindrance of all appears to be a somewhat profound ignorance of the principles of the subject. This, we fear, has been the cause of many failures, and therefore it seems worth while to attempt to give a simple account of the practical principles of pig-keeping, so as to fit it into the common conditions of farming and of rural life as they exist in Scotland. In doing so it seems a suitable plan to discuss the subject under the headings of (1) accommodation; (2) the

principles of breeding and rearing young pigs; (3) feeding; and (4) pig-foods and their use in the production of pig-flesh.

ACCOMMODATION.

The commonest of all arguments against pig-keeping is the want of proper housing, and farmers as a rule maintain that the provision of this is the landlord's part of the business. On the other hand, there is good grounds for arguing that a great part of the food consumed by pigs is either bought in, or consists of material that can be consumed by cattle or sheep, and therefore, where equipment for cattle already exists, the farmer who desires to supplement his business by breeding or feeding pigs may quite well take steps to provide himself with pig-sties; and the fact that it has been shown that pig-keeping is highly profitable, and that the housing required is relatively inexpensive, but adds cogency to this argument. We see no reason for finding serious fault with this view, provided that the landlord is ready to give his assent to the erection of the necessary buildings and to accept the responsibilities that follow such a course.

While we believe it is true that a want of proper buildings is one of the chief hindrances to the development of pig-keeping, it is probably equally true that a want of clear ideas as to what is actually required has also a restraining influence. In the case of horses and cattle, experience has standardised the essentials, but for pig-keeping one will hardly find two establishments in this country alike; and in many that exist it cannot be said that any principles that make for the health of the subject, along with economy in the construction of the buildings and in the labour connected with attendance, are very apparent. Indeed, many places in which pigs are kept are so unsuitable as to be actually hurtful to the health and the wellbeing of the stock, and so inconvenient as to be not only wasteful of human energy, but apt to create a distaste for the work. This is undoubtedly a great source of loss and discouragement to the pig-feeding industry. Hence it is very important that suitable housing should have careful consideration from all who think of embarking on this enterprise.

Suitable houses for pigs need not be expensive. If proper attention is given to the planning, the essentials may be got at no great cost. They should be dry and comfortable, erected so that abundance of sunlight has unimpeded access; nothing is more important, and there should be ample ventilation, with freedom from draught. To these add convenience for feeding

and cleaning with a minimum of labour, and that makes about the sum of the requirements of a good pig-sty. Experience indicates that pigs are ill-adapted to withstand great changes of temperature, and that they are particularly susceptible to dampness. Indeed a cold damp floor and dripping walls in a pig-sty are sure forerunners of disaster. To such causes may be traced many of the troubles that affect pigs—such as rheumatism, bronchitis, and scour in young pigs. Unless the pig-sty is properly ventilated and reasonably free of dampness, good results cannot be expected.

The site and the building material are important factors in making a dry wholesome piggery. The site should be dry and, if possible, in a sheltered situation. Proximity to a piece of ground that can be used as a grass-run is also an advantage, although not essential. The exposure should be good. The buildings should present unbroken walls to the north and to the prevailing wind. On the other hand, the front should look to the sun, and should be constructed so that the interior of the house will receive and retain a maximum of its healthful properties; for sunshine is a big factor in the well-being of swine, and particularly in the successful rearing of young pigs.

As regards material, nothing short of bricks, concrete, or stone is satisfactory for walls. The essentials are that they be warm and weather-proof, substantial but cheap, and easily kept clean. Stone and concrete, as a rule, are fairly expensive, and they tend to be cold in winter. Probably, all things considered, there is nothing better and cheaper than a light brick wall "rendered" with cement. For walls that do not exceed 6 feet in height—and there is seldom occasion to go higher in a piggery—single brick built in a mortar of 1 of cement to 2 of sand, and plastered smooth on the inner surface with the same material, makes a cheap wall which serves the purpose admirably. We have met some who, without trial, have been inclined to doubt the stability of this structure, especially for heavy pigs. To this our answer is that after repeated trials of it, in unsupported lengths up to 16 feet, we have never known it to give way. Of course in special circumstances strengthening pillars of double brick may be used, and these may be made to serve the double purpose of strengthening and adorning the walls. Such a wall is warm, dry, and relatively cheap; and it is easily cleaned. Its external appearance may be improved by a rough-cast finish and a cement wash. The latter may be renewed from time to time.

Next in order of importance, if not in erection, is the floor of the pig-sty. Indeed, it is in many respects the most important part of the building, and the part in which it is most

difficult to combine conditions that are satisfactory from all points of view. Stringent sanitary regulations make it difficult to get past the use of concrete. Unfortunately this material is cold, and is liable to be damp, especially if the foundation is deficient and it is laid on a damp site. A concrete floor may, however, be made fairly satisfactory if it is kept well above the ground level, and given a good foundation of broken bricks or stones. It can be further improved by dressing the top of the rough concrete with tar before laying down the finer finishing layer. This acts as a damp-proof course. A well-constructed concrete floor, with a good fall and not too smoothly finished, is durable, easily cleaned, sanitary, and is fairly suitable for general purposes; but as a rule it is too cold for the farrowing sty, and the use of plenty of litter is only a somewhat imperfect remedy for this drawback. Perhaps the most effective and economical method of dealing with it is to provide a wooden platform, about 6 to 7 feet square, as a bed for the farrowing sty, and for pens in which comparatively young pigs are kept. This is a good thing to have, provided it is laid down so that it can be lifted periodically on its edge and the sty thoroughly cleansed.

A more comfortable floor than concrete is good, hard, close-grained bricks, set on their edge in cement. It provides a better foothold, but unless the bricks are of exceptional quality and glazed, it is not so durable, and is less sanitary than concrete. Another floor which serves fairly well for the inner part of a sty is made by laying, on a properly prepared foundation, a good layer of fine ashes mixed with hot pitch and thoroughly beaten down. Such a floor is warm, but is liable to wear away and become broken and uneven on the surface, which, however, can be cheaply repaired by a new coat of the same material.

All piggery floors should have a fall of at least 1 inch in 5 feet towards the door, so as to provide for surface drainage, and the concrete should be left rough on the surface—finished with a besom—otherwise it will be very slippery when wet and dirty. Bricks set in cement require rather more fall than concrete. There should be no cesspools in the sty; surface drainage should be the rule, and the soakage from each sty should flow into a common channel, which should lead the liquid manure to one well-constructed trap and drain.

A good size and shape for a sty or pen is about 15 feet deep from front to back, and 8 feet wide. This provides ample room for an inner part of about 8 by 6 feet, which is generally reserved for a bed, and may be marked off by a kerb which keeps in the litter, or laid with a wooden platform as already described, and an outer part for feeding and general movement.

Such a sty will provide ample accommodation for about five ordinary sized feeding-pigs, or for a brood sow and litter.

The roof next falls to be discussed. After considerable experience and observation, we are of opinion that, as a rule, the whole sty should be under the cover of a roof. The roof should be weather-proof, and made of non-conducting material. Corrugated iron is too cold in winter and hot in summer, unless wooden sarking is used, and this adds considerably to the expense. It, however, has the advantage that it will serve on a roof of low pitch. Felt and tar is sometimes used, and with plenty of tar and attention it makes an efficient roof for a piggery, but of course it also requires sarking. The merits of tiles and slates are generally too well known to need discussion. All things considered, there is probably nothing in these days cheaper and more efficient than corrugated asbestos-cement sheets. These can be got in various sizes. They are light, thus saving roof-timber, and they are easily attached to purlins that may be set 3 to 4 feet apart. This material, in addition to being durable, is perfectly waterproof, and is a non-conductor of heat and cold. It, like corrugated iron, will serve on a roof of low pitch, and it does not condense moisture and drip like that material. It has therefore many points in its favour as a cheap and efficient roof for a piggery. Its chief drawback is that it has not, so far, been well adapted to take in roof-lights, but these are not often required in a pig-sty.

The air-space, ventilation, and lighting should receive due attention. High roofs and large air-spaces not only add unnecessary expense to the building, but make the sties cold. On the other hand, the ventilation must be so efficient as to keep the piggery wholesome without being draughty. There should also be plenty of light. In the single-row piggery good ventilation can be secured almost entirely by diffusion from the front. This gives ventilation without draughts. Lighting is most cheaply and easily obtained by panes of glass in the front, the upper part of which should be made of a light wooden shutter that can be opened up in good weather for the admittance of plenty of fresh air and sunshine. It will be found that with this arrangement of three close walls and an opening front, there are few days in the year when such a sty will not be comfortable with the front more or less open; and for six or seven months it need never be closed.

To complete our description of a good modern pig-sty something requires to be said of troughs. The best trough is made of glazed fire-clay, semicircular in section and set in concrete. Iron and concrete troughs also serve the purpose, although the animals do not appear to appreciate these materials so much as fireclay, and seldom keep them so clean. Besides, a large iron

trough will soon rob the food of any heat it contains. For a sty in which several pigs are to be kept, ample trough accommodation for the number of the pigs in the pen should be provided at the front wall, and it is a great advantage in feeding to have the trough set in the wall with a hanging door over it. When the door is hung from a horizontal iron rail immediately over the centre of the trough, it may be pushed inwards before feeding and fixed in that position with a strong bar, thus shutting off the pigs from the trough while the food is being put in. The door can then be released and swung to the outer side of the trough and fixed there, thus giving all the pigs access to the food at the same time. When a number of pigs are kept together, such an arrangement saves much scrambling at feeding time, which frequently results in waste of food, and the trough can be cleaned out and the food put into it without the attendant entering the sty. For the breeding pen, however, the advantages of this arrangement tend to disappear. In this case a fire-clay trough of ample size set against the front wall, and securely fixed and finished off with cement, is quite efficient. It is cheaper, and for one animal is preferable to the long trough and swing door, which has the serious drawback of being much too large for one animal requiring careful feeding.

The reader may now be referred to page 93, where a plan of such a sty as has been outlined is given in the form of a row of five breeding pens. This is a very useful unit as an adjunct to the housing accommodation of an ordinary farm steading where pig-breeding is contemplated. It will provide farrowing and nursing accommodation for about eight sows or sixteen litters per annum, as well as suitable houses for giving the young pigs that are to be fed on the farm a good start in life before being shifted into cattle courts, where, along with cattle, they do very well for a good part of their life, and can be kept at little expense and inconvenience if proper attention be given to a few details. The complete cost in ordinary times of erecting such a unit would be about £80, and on the farm this outlay can often be considerably reduced. The plans need little or no explanation in the light of what has been set forth as the requirements of a good sty. The ground plan shows the size and shape adapted for the work. The iron rail around three sides of the "bed," which is neatly jointed by tee-shaped pieces where the side and back portions meet, and is firmly supported by passing through the partitions at the back, and having the ends towards the front of the stall turned downwards and slightly outwards into the concrete floor, helps materially to protect the young pigs during the first week or ten days of their existence, and will save many lives during this critical period, when sometimes the greater part of a litter

is wiped out by restless and clumsy mothers overlying them Properly erected, of 1½-inch iron tubing, this guard will serve

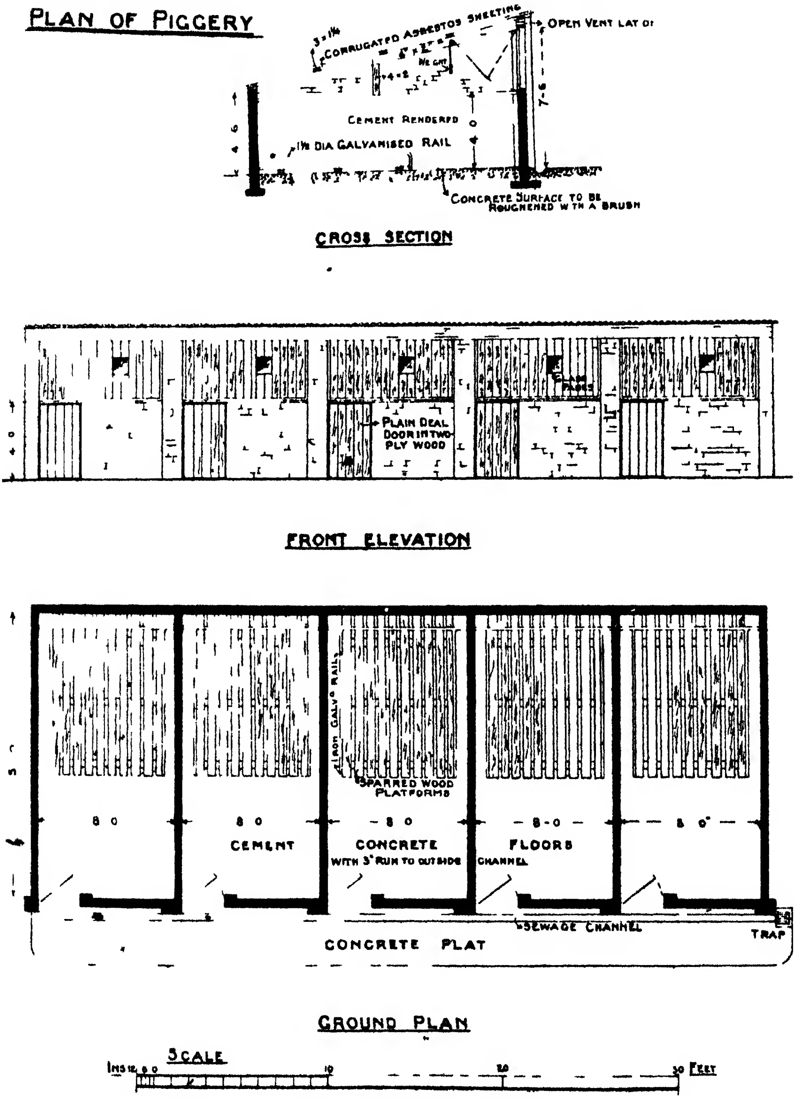

Fig. 12

a lifetime The wooden platform, recommended for farrowing sties and young pigs, is seen in position, pushed back under the rails to the back wall, but of a size that permits it to be lifted

clear of the side rails, and raised and propped up to admit of thorough cleansing periodically. The trough is not shown. It should be set against the front wall. The doors are hung to swing inwards, and open against the partition walls. This is an advantage, particularly when the attendant has to enter the sty, as with one hand he can open the door and close it behind him, whereas a door opening outwards is less convenient to manipulate. It is liable to be pushed open, thereby allowing the pigs to escape, and much time may be lost in getting them back.

The cross section is made to show the dimensions, the partition, and the support which the latter may be made to give to the roof, thereby reducing the roofing timber to one light couple per sty, which is sufficient to carry the purlins to which the light asbestos-cement roofing is firmly fixed by strong galvanised screws and washers. The upper part of the front of the sty is hinged, and balanced by weights suspended from each lower corner by cords, which pass over swivel pulleys fixed to the couples. Arranged in this way, the door readily passes up out of the way on being lightly pushed, and remains there until pulled down again. When this front looks to the south, and is open, each sty is flooded for most of the day with direct sunlight. The cross section also shows provision for cheap and efficient ventilation—namely, a few of the corrugations of the roof at the back are left open to let in fresh air over the pigs without draught, while the foul air is given ample egress when the front is closed by leaving all the corrugations of the roof open at the front.

The front elevation shows the general appearance of the building. The walls are strengthened and broken up into panels by a pillar between each sty, and the swing doors each carry a pane of glass, which should be a little larger than that shown, and should be in the centre of the door. This serves for lighting the interior, and allowing the attendant to see what is going on inside when the door is closed. The photograph given on page 95, showing a row of houses recently erected by the writer, will also serve to illustrate the general appearance. The doors are most simply and efficiently secured by turning wooden buttons, fixed by bolts as shown in the photograph, which should be large enough and so shaped as to serve also as handles.

So far we have discussed exclusively what may be called a single-row piggery, believing that this is the type best adapted to the ordinary circumstances of this country, particularly when the business of pig-keeping is to be conducted on a small or a moderate scale, because it is relatively cheap, and when properly set down, with its face to the south, it is efficient. Above all, it is well adapted to promote health, as it does not bring

together a large number of pigs under one roof. In any design of piggery that does this, special provision has to be made for air-space and ventilation, otherwise the atmosphere of the piggery is apt to become so close and moist that young pigs at least do not thrive well. In America, however, and also Canada, where pig-keeping is an extensive and highly developed industry, one of the commonest forms of housing is what may be termed the double piggery, which consists of two rows of sties, similar to the single piggery which we have described, standing face to face, with a feeding passage between them, and all under one roof. No doubt the severer winter

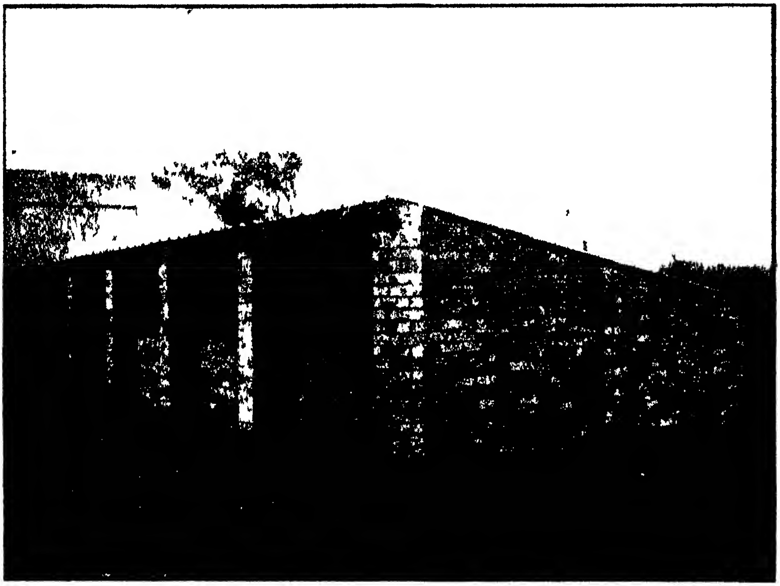

Fig. 13.—*Single row piggery erected by writer*

climate there makes imperative closer winter quarters than will suffice with us, and in a larger establishment a compact arrangement saves labour. The difficulties that present themselves in the double piggery are the provision of ample air-space, ventilation, and direct sunlight, and no small amount of ingenuity has been exercised to secure these desirable qualities. Nevertheless the double piggery tends to be too comfortable and relaxing, with the result that the pigs take too little exercise, and various forms of ill-health tend to appear, such as indigestion, constipation, lameness, coughing, and weak, badly-nursed litters. After careful consideration of a great variety of double piggeries, we put forward the

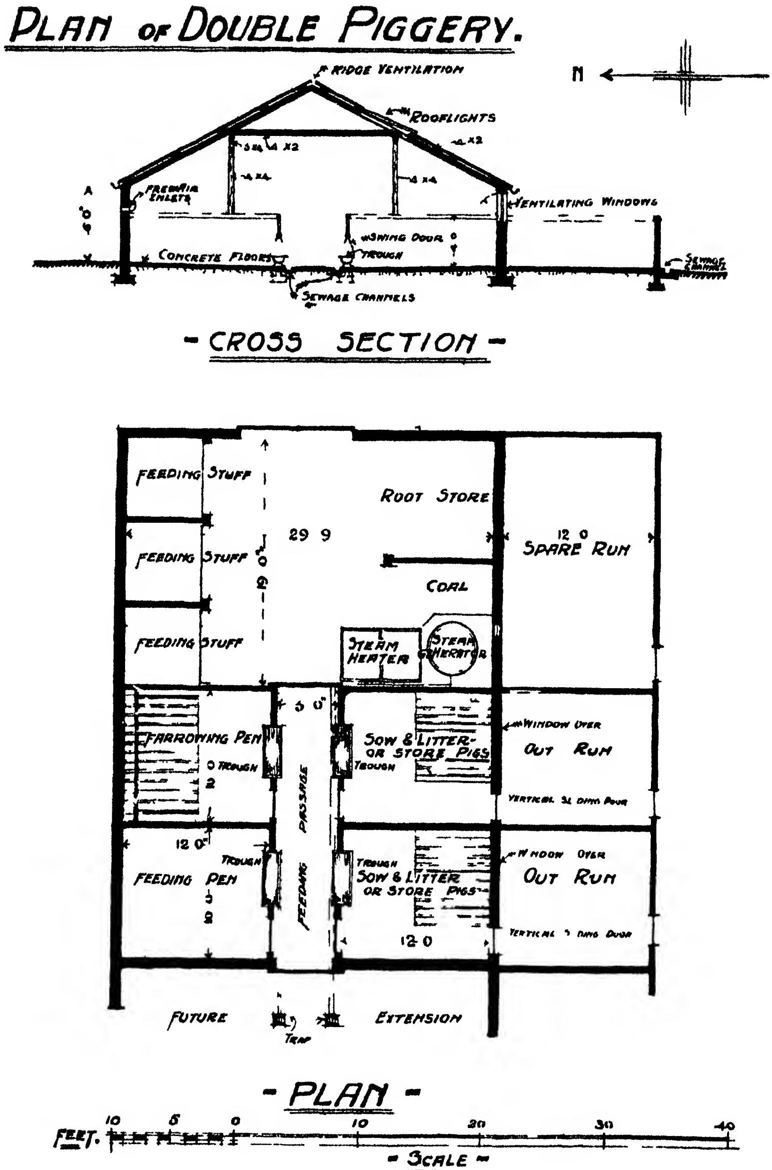

Fig 14

arrangement represented on the plan given above (Fig 14) as at least suggestive The range of buildings should again

run east and west, so that there may be a "face" to the south. Light is got by direct sunshine from the windows on the south side. The important point in this arrangement is to place the row of windows in the south wall in a position so that as much light as possible will fall on the floor of the row of sties on the south side, especially in the dull half of the year; and in the same way those on the north side should get light from a continuous row of glass in the roof, so placed that the direct sunshine will fall on the floor of the sties. The position of these windows requires to be carefully considered in relation to the height and width of the building, and the angle of incidence of light during winter. Ventilation will be best secured by ventilators in the north walls, ventilating windows in the south, and an ample outlet for foul air at the ridge. The latter need not be complicated and expensive, for a simple continuous opening about 1½ inch wide all along the ridge will, we believe, suffice and give no trouble. This will always be open for the escape of foul air, and yet sufficiently close to keep out sparrows. Experience of this arrangement seems to indicate that any rain or snow that can find its way in at such an opening is of no account, especially when it is not directly over the animals. The inflow of fresh air can be regulated at the inlets and the windows in the walls. The arrangement provides for feeding and cleaning from the central passage. The sties along the north side have no outruns, but without them they are suitable for farrowing sows and young litters coming during cold weather, as very young pigs are better to be restricted to the sties in cold weather, and also for pigs in the final stages of fattening, as close quarters at this period are favourable to rapid and profitable gains. Those on the south side, however, with ample inside accommodation and a roomy outrun which can be cut off by a door 2 feet × 2½ feet, sliding up and down, is well adapted for sows with litters well started, and for store pigs of all kinds, which should be encouraged to go outside by having at least their forage and vegetable food served there, except in the severest weather. Of course, although only a few sties are shown on the plan, obviously it can be extended to accommodate a large herd. The other features of the arrangement are in accordance with the general principles laid down in discussing the single piggery.

Breeding and Rearing Young Pigs.

A detailed discussion of the merits of the various breeds of pigs is scarcely within the scope of this article. By careful breeding several breeds have attained a high degree of merit,

which has become sufficiently fixed to provide considerable choice of suitable material for the economical production of pork. Attention, however, may be directed particularly to the great outstanding qualities of the Large and the Middle Yorkshire breeds for this purpose, although it need not rest exclusively on them. Within these two breeds, either pure or cross-bred with each other, will be found pigs that will serve almost any commercial purpose. The Large Yorkshire is hard to beat as a bacon producer, where there is plenty of good strong food. They stand heavy feeding particularly well, and are generally preferred where much rich kitchen refuse is available, because pigs of this breed grow rapidly, and when heavily fed they put on flesh well at the same time. With less forcing food the Large Yorkshire may in early life grow somewhat lanky, and become too big for certain purposes before getting into good condition for killing. In this case the Middle Yorkshire, or a cross between these two breeds, provides a thicker fleshed type of pig and is probably the more suitable animal where only moderately stimulating food is available. Indeed the cross between the Large Yorkshire sow and the Middle Yorkshire boar is a pig that is hard to beat for general usefulness. Both these breeds also cross excellently with sows of the Large Black or Sussex Black breed, and also with sows of the Tamworth and the curly-coated Lincolns. Sows of all these breeds are hardy, good foragers, and being as a rule good milkers and mothers, they rear their litters well. Cross-bred pigs produced in any of these ways are hardy and grow rapidly, and if bred from well-selected boars of good pedigree they are likely to have all the quality necessary for the economical production of pork.

In making a selection of pigs it is of practical importance to recognise two types, which may be called respectively the *pork* and the *bacon* types. The former is wanted in large centres of population for the fresh pork trade. For this market the most suitable pig is a fine-boned, well-fleshed, compact pig of medium length and possessing early maturing tendencies. The pork pig should mature so as to yield a finished carcase of 100 to 130 lb. when 5 to 6 months old. The bacon-curer, on the other hand, desires a pig that will weigh about 160 lb. dead, and yield long, deep sides, containing a high proportion of lean meat. Therefore, the pig that is likely to be most suitable for the bacon-curer is one that is rather lengthier in form, and has a greater tendency to grow to size than the pork pig. It has about two months longer to live to reach the required weight. The Berkshire and the Middle White may be taken as illustrations of the pork pig, and the Large Yorkshire breed provides a high pro-

portion of first-class examples of the bacon-curer's pig; but both types can be selected within the latter breed.

In selecting pigs for breeding, great care should be taken to secure really good pure-bred boars, which conform as nearly as possible to the type desired. Indeed, in looking for a boar, probably the safest course is to visit the herd of a breeder of repute, make a selection, and buy after seeing the sire and the dam, and if possible others of the same strain as the animal selected. In making the final choice preference should be given to a boar from a large, even litter, as fecundity is hereditary, and the power to produce good litters is an essential in successful pig-breeding, and a good even litter is the best indication one can have. A tendency to hernia or rupture is also hereditary, and it is therefore desirable to avoid strains containing this troublesome taint. Indeed, in the economical production of pig-flesh, no step is of more importance than that of securing service from a superior pure-bred boar. A brawn eight months old, if well grown, is fit to serve a considerable number of sows. He is best kept by himself and given the sows as they come in heat. By this means, rather than by allowing him to run with the sows, his breeding power is conserved. Besides, he can be properly fed, and is less likely to come by accident. In this connection it is also well to remember that one service is ample for the production of a large litter. Indeed it appears to be better than more, and one should not only avoid exhausting the boar with unnecessary service, but also serving several sows closely on each other with the same boar. We have frequently observed that when several sows were put to the same boar within a few days, the litters from the later-served ones tended to be small.

In selecting a sow for breeding, it is not so essential as in the case of the boar that she be pure bred, if she be suitable in other respects; but it is of importance to ascertain that she is the progeny of quiet, thriving parents, for an irritable restless mother is frequently the source of disaster at farrowing time; that she is of a good milking strain; and that she is possessed of at least twelve well-developed teats, regularly spaced along the belly and extending well forward on the breast. No good results in pig-breeding are likely to be obtained unless these points receive careful attention. Young sows should generally be selected from large, even-sized, well-nourished litters; and spring litters are to be preferred, because the young sows will as a rule grow and develop better in summer than in winter, and with proper management they can be put to the boar at about eight months old, and will thus generally produce a satisfactory litter within twelve months of their birth. A sow selected and managed in this

way, should she prove a good breeder, may continue to rear two good litters annually for three or four years. While no breeding stock should be allowed to become fat, young sows require to be liberally fed so as to encourage good growth.

In the management of breeding sows, the essentials are plenty of exercise, suitable food, and a dry comfortable bed. These can be secured in a variety of ways. An excellent method of keeping pregnant sows is to run a number together in a well-fenced grass enclosure, preferably in a sheltered situation. If this is provided with a roomy shed, sows may be kept, with very little labour, in the best possible condition during the greater part of the time they are not nursing. Sows kept in this way get plenty of exercise and come in to farrow in fine muscular condition, which gives them good command of their movements in the farrowing pen. This is one of the chief factors that lead to the rearing of large litters. Moreover, on a grass run sows can find a considerable part of their food. With plenty of succulent grass little else is needed. When the enclosure does not provide this, a few roots—potatoes, turnips, or similar foods—may be scattered in it. It is during this period that sows may be kept very largely on waste material. Sows in these circumstances will do very well on one light diet daily of sloppy meal, such as sharps, or, when available, the refuse from distilleries known as dreg. This treatment, along with a dry bed, is suitable up to within three or four weeks of the time when they are due to farrow. Then they require better food, and should be removed from the herd. Circumstances will determine whether the sows should now be put into the farrowing sties, but at any rate they should occupy them long enough, say a week, to settle before farrowing.

Another good and cheap method of keeping sows is to run them in a roomy shed, such as a cattle court. It may not be always convenient to follow either of these methods very closely, but the essentials to remember are plenty of exercise, regulation of the diet, and a dry bed. When breeding sows are closely confined in dirty, damp sties they are very liable to suffer from rheumatism, and any tendency in this direction may result in the entire litter being lost.

The time at which the sow farrows is a rather important factor in getting good results. Two litters per annum is the rule, and it is highly desirable that farrowing should take place during the warmer months. Above all, the dark damp days of November and December should be avoided. The first litters of the season should come, if possible, in February or March, and the second in August or September. In preparation for farrowing, the sow should be fed on a nourishing diet during the last month of pregnancy; for the drain on the sow at

this time is considerable, and a few weeks' feeding on easily digested, laxative food helps both to produce strong pigs and to bring the mother into the best condition for bearing and nursing them. If the farrowing sty is available, she can best be attended to there. It should be moderately roomy—a good size being about 8 feet wide and at least 14 feet long—and owing to its importance we repeat here: it should be situated so as to get abundance of sunlight, and it must be free from draughts and dampness. A desirable provision against cold and dampness is a movable platform of wood laid on the concrete floor, for the sow to lie on; and to protect the young pigs from being crushed between the wall and the sow when she lies down, the sow's bed should always be surrounded by a strong rail, firmly fixed 8 to 10 inches from the floor and the same distance from the wall. Many pigs are lost during the first days of their existence through neglect of these precautions. The bed should be littered with very short straw or chaff. The farrowing sow as a rule needs little attention. She is frequently very sick and lies quiet, but at other times she moves about and is very excitable. Frequently the young pigs are better out of the way, and when this appears to be necessary they should be placed in a comfortably littered box till they are dry and the farrowing is finished. But if this is prolonged they should, as the circumstances of the case permit, be put to the sow's breast for a few moments in order to obtain nourishment.

After the farrowing is over the sow should be given some warm sloppy food, and the bed made up with a very limited amount of short litter. She will then, as a rule, take to her pigs, lie down, and rest. At this time, however, the attendant should not be far away, for sometimes the young pigs are born with long, sharp, discoloured teeth which injure the tender breast of the dam. In this case these teeth should be broken off with a pair of pincers, due care being taken to leave no sharp fragments. All litters do not by any means require this attention, and the need for it is usually indicated by the sow refusing to suckle her pigs. If it is neglected she may even attempt to do them serious injury. Again, sows may be so clumsy after farrowing, or the pigs so weakly, that it is necessary to protect them for a time. The remedy for this is to keep them in a box beside the sow for a few days, and put them to her to be suckled every three or four hours. This precaution is frequently required with sows that are large and have been allowed to become too fat; but while in some cases it is very desirable, it should not be practised unless it appears to be absolutely necessary.

The feeding of the nursing sow requires great care in order to raise a litter of plump, well-nourished pigs, and at the same

time to avoid digestive troubles, particularly scour, which in a few days will ruin a promising litter. An hour or two after farrowing the sow should be given a drink of very thin warm gruel—simply warm water with a few handfuls of meal or fine wheat thirds stirred into it. The feeding for the first two or three days should be very restricted. After that the sow will usually give indications as to her requirements. By the end of the first week she should receive all that she will eat up clean. The suckling of a litter is a severe strain on the sow, and the ration should now be liberal and well adapted for milk production. If she is a good mother she will fall away in condition and her pigs will thrive and grow very rapidly, and if she is not supplied with plenty of easily-digested, nourishing food, she will fail to make the most of her offspring at a time when the most economical gains can be made. Moreover, she may become so reduced as to temporarily impair her capacity for breeding, and time will be lost in getting the next litter, or it may be small or weakly. Dairy by-products are very valuable at this time, although not essential for success, and of the grains, wheat-offals and oats are among the best. A very good meal for this purpose is a mixture of 1 part bran, 2 parts sharps, and 2 parts parings or thirds. A sow with a good litter will consume from 9 to 12 lb. of this meal daily. It should be prepared by being properly scalded with boiling water, and after standing for several hours, fed in a warm sloppy condition. Cooked potatoes or other vegetables, or a small amount of sound kitchen refuse, may be added with advantage; or, failing this, the sow should be given a moderate allowance of raw turnips or other succulent vegetables. Variety of food is desirable, but sudden and radical changes should be avoided; and refuse collected from kitchens, slaughter-houses, and distilleries, especially if it is not fresh, should be excluded from the diet. Heating and fattening meals, such as maize and barley, should also be avoided.

Once the young pigs are well started every opportunity should be taken to permit them to take exercise. Warmth, sunshine, and fresh air are great factors in promoting their rapid growth; but long exposure to strong, summer sunshine should be avoided, as this frequently causes sunstroke, which very often is fatal.

By the time the young pigs are about a month old they begin to seek additional nourishment, and probably the best way to encourage them in this is to feed the sow in a wide flat-bottomed trough. If a trough of this kind is used the youngsters soon learn to share the mother's rations, and then they may be given access to special provision for themselves. This should be given three times a day, and should consist of skim-milk,

separated milk, or fresh butter-milk, which may be mixed with some boiled potatoes and a little bran, sharps, or other wheat offal. Where no milk is available, the next best thing is a mixed meal of easily-digested ingredients, such as wheat-parings, sharps, oatmeal, sifted ground oats, biscuit meal, and linseed meal. This should be fed warm and sloppy, and no more at a time than is readily eaten up. If it is given too thick or too liberally, the young pigs, especially if the dam is milking freely, are liable to suffer from convulsions and may die. This feeding should be continued for three or four weeks, when they will have had a good start, and the sow may then be separated from her offspring for part of each day and ultimately withdrawn without any disturbance. She should, unless very much reduced in condition, be put to the boar again as soon as she comes in season. This will usually take place a few days after she has been removed from her pigs. Sometimes a sow, especially if in high condition, will come in season while nursing. In that state she is usually irritable and dangerous to her offspring, and if not given immediate attention may kill some of them. She should be turned out temporarily from her litter and served, or if this is thought inexpedient, kept away from her pigs as much as possible till she resumes her normal condition.

It is also very desirable—indeed it appears necessary—that a nursing sow and her litter should have occasional access to earthy material, small coal, or wood ashes. This appears to be necessary as a stomachic, and when it is inconvenient to allow access to mother earth, such as an occasional run on a grass field, the object can be attained by giving on occasion sod or a supply of some other earthy material.

Generally the best time to wean the pigs is when they are about seven or eight weeks old. By this time they are well started to eat, and with proper attention to dieting will go on thriving even without milk. In some districts it is the custom to wean pigs at five to six weeks old. As a rule this is not to be recommended. It is in the interests of neither breeder nor feeder. At this age the young pigs are hardly fitted to live entirely on a meal and vegetable diet, and unless milk is available their growth may be seriously checked. With good suckling and careful feeding, pigs between five and eight weeks old make very rapid growth, and after this will not only fetch considerably higher prices but generally give the buyer much more satisfaction. Therefore the breeder usually gets both a higher price and a readier market, and, with good management, two litters per annum can still be got.

Few attempts appear to have been made to estimate the cost of producing pigs, and this varies a great deal in practice.

Food is the chief item. Sometimes a good deal of cheap food is available, such as refuse roots, waste forage, &c. Breeding sows when not nursing can make good use of material of this sort, and thus the cost of their upkeep may be considerably reduced. But in reckoning the cost of a sow's keep, it is better not to overestimate these advantages.

As a foundation for calculating the cost of producing young pigs, it may be assumed that a well-managed sow can produce a litter and nurse her young for seven or eight weeks all within six months. This time may be divided roughly into a period of expensive keep, which commences two or three weeks before farrowing and ends when the pigs are weaned, or about ten weeks altogether; and one of about sixteen weeks, during which the sow should be kept cheaply on coarse inexpensive food. During the former period a liberal allowance of nutritious food is required, and for a time the sow and her litter may consume up to 12 lb. of meal per day. Of course no hard-and-fast division exists between the cheap and the expensive periods. The former merges into the latter, but roughly they may be taken as sixteen and ten weeks respectively, and the average cost of keep, putting a fair value on home produce, is about 2s. per week in the one case and 4s. in the other. On this reckoning, and taking pre-war prices, the cost of keeping a brood sow during the period necessary for producing and rearing a litter of pigs is about £3, 10s., or approximately £7 per annum.

The other important items of expense in the production of a litter of young pigs are housing and attendance. It ought not to be overlooked that sows when farrowing and nursing require a good deal of comfort and attention, and it is easy to underestimate the actual cost. This, along with depreciation and incidental expenses, probably cannot be put at less than £4 per annum. The total cost of keeping a brood sow would thus be about £11 per annum. During that time she produces two litters, and it is a very satisfactory result if, on the average, sixteen good marketable pigs are weaned.

If the cost be fully reckoned, it thus appears that pigs eight weeks old cannot be produced for much under 13s. or 14s. per head. The live weight of young pigs at this age, when reared without additional milk, should be about 26 to 28 lb., and the average price realised for them over a period of say eight years before the war would be roughly about £1 per head.

Pig-feeding for the Production of Pork.

A considerable number of experiments have been conducted with most of the cereals, roots, and dairy by-products, in order to determine the relative merits of different rations, and to

discover, if possible, the best method of feeding them. Unfortunately many of the best of these experiments have been conducted abroad, particularly in America, under conditions somewhat different from those existing in this country. Nevertheless there is a considerable accumulation of information from this source, which, along with that derived from general experience, is of great assistance in shaping a proper course for the pig feeder.

The feeding of fattening pigs may be said to commence at weaning time, for it has been well demonstrated that the old plan of having a long store period for growth, followed by a very intensive fattening one, is not an economical method of producing pork. Pigs kept for this purpose should have a short life. They should be kept going forward from birth, for when young they give a considerably greater increase per unit of food consumed. This fact is very well brought out in a series of experiments conducted by Professor Day at Guelph, in which it was found that the food consumed for one pound of live-weight increase was as follows: While increasing in live weight from 54 to 82 lb., 3·10 lb. meal was consumed per pound of gain; from 82 to 115 lb., 3·75 lb. was required; from 115 to 148 lb., the quantity was 4·38 lb., and from 148 to 170 lb., it went up to 4·55 lb. of meal per pound of live-weight increase. This statement indicates that as the pig increases in weight there is a steady increase in the amount of meal required to produce a pound of increase, and when this is taken along with the fact that in this country the price obtained per pound falls off as the pigs get heavier, it points to the economy of marketing the fat pig comparatively early in life. Professor Henry also gives a large amount of similar data, derived from numerous experiments, which show that the food required per lb. of gain by pigs 300 lb. in weight is well over 5 lb., or nearly double that consumed by newly-weaned pigs for the same increase.

Experience indicates that after being weaned young pigs should continue to get their food in a sloppy condition. The meal may now be a mixture of sharps and parings, or either of these, with fine barley-dust, ground maize, oats, or barley. The use of two or more of these ingredients in mixture is better than feeding exclusively with one of them. The slop may contain with advantage cooked potatoes or vegetables and kitchen refuse, which, however, must not be very rich for pigs of this age. At this stage, three full meals a day are required, but no food should be allowed to stand in the troughs. Young pigs should be well fed but not overfed. It is only when fed regularly that they give the most satisfactory results. They should have a dry bed and a fair amount of exercise. An occasional run in

a grass field or other suitable place will do much to keep them in good thriving condition.

In addition to the sloppy food, growing pigs may get with advantage an allowance of raw turnips, cabbages, or other succulent vegetables. By the time they are three to four months old this may take the place of the midday meal. Pigs at this age should be strong enough to thrive on a great variety of food, including refuse materials, and frequently they are fed very cheaply when these are available. As the pork pig gets up to 1 cwt. and the bacon pig to 1½ cwt. in weight the exercise so desirable at an earlier stage should be limited, and some modification in the feeding may be necessary in order to provide a superior carcase. For example, certain foods, such as rich kitchen refuse, waste fish and meat, and by-products from breweries and distilleries, produce soft inferior pork, and therefore in the final weeks of fattening should be withdrawn, at least partially, and replaced by a substantial amount of meals that are known to give a good finish. Highly suitable for this purpose are barley-meal, barley-dust, pease-meal, ground maize, ground oats, and wheat-offals. These are all noted for their good effect on the quality of the pork. Turnips and suchlike feeding should also be discontinued, and the food should be presented so as to encourage the pigs to eat heavily three times a day.

As regards the quantity of food and rate of progress, we cannot do better than quote from a table given by Professor Henry, as the data which he gives is based on a large number of experiments. These figures show that pigs of an average weight of 38 lb. consumed 2·23 lb. meal daily—meal meaning any good pig meal or its equivalent,—and they made an increase of about ¾ lb. per day. And in experiments with about 500 animals, of an average weight of 128 lb., the average daily feed consumed was 4·79 lb. meal, and the increase 1·10 lb. per head per day. When the pigs got up to 226 lb. live weight they consumed about 6½ lb. meal per head per day, and increased at the rate of 1⅓ lb.

These figures provide the means of calculating the cost of producing pork. They indicate that it takes from 3 to over 5 lb. of good feeding meal, such as barley-meal, maize, wheat middlings or parings, to produce 1 lb. of live weight increase. The amount varies with the age and condition of the pig, the greater quantity being required in the final stages of fattening, and when the animal gets up to and over 200 lb. live weight. But as fattening pigs are usually killed when they reach this weight or soon after, the amount of meal required to produce 1 lb. of live weight increase will usually not exceed 4½ lb.; and as the ordinary fatted pig is reckoned for practical purposes to yield 75 per cent of its ordinary live weight as carcase, a

general calculation of the cost of producing pork can be based on these figures. A young pig weighing, say, 28 lb., is bought for 20s., and is fed with meal or its equivalent until it has added 200 lb. to its live weight. At the rate of 4½ lb. of meal per lb. of live weight increase, which will be equal to 6 lb. of meal per lb. of pork, the quantity required is 900 lb., or practically 8 cwt. If the meal costs 7s. per cwt. the outlay on the pig and the food amounts to 76s. The fatted pig weighing 228 lb. should yield at least 75 per cent of its live weight in carcase. That is, 171 lb. of pork is produced, which at 6d. per pound or 7s. per stone will be worth 85s. 6d. The variables in the calculation are the cost of the meal and the price obtained for the pork, but these figures can be changed according to current prices.

Of course, the profit will be much greater when cheap food is available. As a rule, pigs would not be fed solely on meal, but to a greater or less extent on home-grown foods, by-products, &c. As an instance, it has been shown that 4 tons of potatoes, which when cooked are highly suitable for pig-feeding, are the equivalent of at least 1 ton of the meals referred to; and making due allowance for the extra labour connected with their preparation, they can usually be purchased so much cheaper than their meal equivalent, that their use would add considerably to the profit of pig-keeping. Similarly, 8 tons of turnips or mangels fed raw may be taken as more than the equivalent of 1 ton of meal. The possibilities of roots as pig foods appear to be little understood in this country. They have been experimented with extensively in America. Professor Day found that well under 600 lb. roots used in conjunction with meal at Guelph effected a saving of 100 lb. meal. The result demonstrated the value of roots when fed in limited quantities—namely, equal parts by weight of roots and meal. It was found that the pigs getting roots made large daily gains, and as the tendency was to grow rather than to fatten, the quantity has to be reduced in order to finish the pig for the market. The pigs receiving roots not only made larger and more economical gains, but also produced a finer quality of bacon than those fed on grain alone.

In Denmark, where pig-feeding has long been a most important branch of farming, 6 to 8 lb. of mangels are regarded as the equivalent of 1 lb. of barley.

American authorities on pig-feeding hold that the special value of roots and forage crops, such as rape, clover, vetches, &c., lies in their effect on the digestive system. They appear to sharpen the appetite and increase the digestive capacity. In all experiments in which any of these forage crops have been added to a liberal grain ration, the pigs have made more rapid and cheaper gains than when fed on grain alone; and in those

experiments in which the quality of the product is reported, the experimenter comments favourably on the lots receiving this addition to the grain ration.

FOODS AND FEEDING STUFFS.

Space will not permit of more than brief reference to the chief foods that are used or might be used in this country for pig-feeding.

Barley and Barley Offals.—Ground barley or barley-meal has long been very highly esteemed for pig-feeding. This is particularly the case when the quality of the product is taken into consideration. It is usually held to be the only cereal that can be fed alone with good results; but all grains are better fed in mixture, and barley-meal or ground barley goes very well with wheat offals, ground oats, or dairy by-products, especially for finishing off pigs. Of course there is a limit to the economic use of barley. Experiments have shown that pigs fed on maize and rye in place of barley make similar increase per cwt. consumed, and these foods can often be bought at less money. The by-products of barley, such as fine barley-dust, share with barley its reputation, and they are generally much cheaper. Coarse barley-dust, on the other hand, cannot be regarded as a very valuable food for pigs, although it is sometimes useful for mixing with heavy concentrated meals. Barley, however, it should be noted, is not very suitable for nursing sows. It is reputed to have a tendency to induce a feverish condition of the system which affects the milk so as to cause loss among young pigs. It is really in the final stages of fattening that barley has its highest value in pig-feeding.

Maize or Indian corn is one of the most effective feeding-stuffs for fattening pigs. It should always be ground into a fine meal, which should be fed only as a part of a meal mixture. In the actual production of increase it is probably more effective than any of the other grains. But it is not a complete food, being rich in starch and oil and low in ash and protein; it is a potent heat and fat producer, but not well suited for young and growing pigs. Its proper use is to supplement foods rich in protein, particularly in the later feeding stages. It does well with wheat offals and oats, especially if pea-meal or some animal product fairly rich in protein, such as meat-meal or fish-meal or skim-milk, can be added.

Wheat and Wheat Offals.—Wheat has a high feeding value for pigs, probably similar to maize; but with the exception of light and damaged samples, wheat is usually too dear to be used for this purpose. Wheat offals, however, such as fine

wheat middlings or parings, are extremely valuable for both young and old pigs. They have a special value for nursing sows and young pigs owing to the large amount of ash which they contain. Young pigs thrive on this food better than on almost any other meal. For fattening pigs it is also excellent, but is reputed to have a tendency to produce soft pork unless used in combination with peas, barley, or other grains. It is excellent, for all purposes, along with dairy by-products. The same applies to the coarser product generally known as sharps but bran, on the other hand, is too coarse to be of high value for pig-feeding, except in limited quantity to lighten up heavy meals. It contains too much fibre to be well digested by pigs, and on this account it is unsuitable food for young pigs.

Oats and their By-products.—Oats well crushed or ground make a first-class food for mixing along with the finer meals, such as maize-meal, fine barley-dust, and fine parings; but oats alone are too husky and contain too much fibre to make a good food, and, as a rule, unless exceptionally cheap, they are not economical food for pigs. Oat by-products, such as oat-dust, and particularly scree-dust, both obtained in making oatmeal, have a limited value, and their value for pig-feeding is often overestimated. They are useful, however, for mixing with more concentrated meals when the bulky food is limited.

Pea-meal and Bean-meal.—Pea-meal is a good food for swine, if used in small quantity, and in combination with other meals and roots—such as potatoes. It is valuable inasmuch as it has a very good effect in improving the quality of the pork, and being rich in protein, it improves a ration containing a high proportion of maize or potatoes. While pea-meal has been found good, American experimenters report very unfavourably of bean-meal. Pigs appear to make unsatisfactory gains on mixtures containing it, and it appears to produce a high proportion of soft carcases.

Distillery By-products.—These are chiefly draff and dreg. The former is too coarse and fibrous for use as a pig food by itself, but where it is cheap, as in the neighbourhood of distilleries and breweries, it can be used in combination with the finer meals, such as maize and fine parings, for all classes of pigs, and considerable quantities may be used for feeding brood sows. Dreg, or the finer sediment from the mash-tub, is much more suitable for pigs. It is obtained both as a paste and as a thin slop. The former usually costs 15s. to 30s. per ton, and contains about 25 per cent dry matter. It will bear a limited carriage, and still be a cheap feeding-stuff. The latter is a very watery food, and as it seldom contains more than 3 per cent dry matter, obviously it must be consumed near its source. With the addition of very little meal, it is used very extensively in

pig-feeding in the neighbourhood of Edinburgh, being got at the distilleries, where it is usually sold at about 1s. for 100 gallons. Its cheapness is the factor that determines its use in this way. It is really too watery in itself to make an economical food, and it makes a soft second-rate product. The use of a greater quantity of suitable meal would remedy this defect and give better results from the use of this by-product.

Rice By-products.—Rice-meal or rice-bran, when good, is satisfactory and often a cheap food for pigs. The difficulty about rice-bran is that it is variable in character, frequently containing a considerable amount of rice hulls. This increases the percentage of woody fibre, and greatly reduces the value of rice-bran as a food for pigs. Experiments have shown that good rice-bran is little inferior to maize, and being often considerably cheaper, it is a food that should receive the attention of pig-feeders. It is very suitable as a component of pig-meal.

Linseed and its Products.—Linseed-meal, or ground linseed-cake, is a suitable food for young pigs, and may be used to a limited extent as a food, both for them and for nursing sows, where dairy products are not available. Not more than a tenth of the mixture should be linseed (see p. 103). Ground linseed-cake is less suitable for this purpose—it contains more fibre.

Cotton-seed Meal.—Yellow meal or ground decorticated cotton-cake, a food much appreciated in the dairy, has not been found to be a very good food for pigs, although some experiments have given good results from its use along with maize and rice-meal. Cotton-seed meal is very concentrated, and experience indicates that when used in considerable quantities it may be fatal to pigs. Undecorticated cotton-cake, ground into a meal, contains much fibre, and should not be fed to pigs.

Meat-meal; Fish-meal.—These animal products are rich in protein and oil. Besides, they are digestible, and appear to be very much relished by pigs. After extensive trial over several years, the writer has found them next in usefulness to milk in rearing young pigs.

Dairy By-products.—These have such a high value in pig rearing, particularly skim-milk and butter-milk, that some farmers appear to think them indispensable. This is an entirely erroneous idea, which is prejudicial to the development of pig-keeping in this country. The writer has reared over 300 pigs annually for many years without milk, and many breeders away from the dairy districts do the same without dairy by-products. Nevertheless, a limited amount of milk fed along with suitable meal has been proved to have a value considerably beyond what would be expected from a study of its composition. Professor Henry, as the result of extensive experiments, found that in

feeding 1 lb. of maize-meal with from 1 to 3 lb. separated skim-milk, 327 lb. skim-milk saved 100 lb. meal; but when the proportion of milk was gradually increased up to from 7 to 9 lb. per pound of meal, 823 lb. was required to save 100 lb. maize-meal. This result has been corroborated by other experiments. Usually about 6 lb. separated milk is reckoned equal to 1 lb. maize or fine middlings.

Roots and Forage Crops.—This heading embraces potatoes, sugar beet, mangels, swedes, cabbages, rape, vetches, clover, grass, and green stuff generally. Reference has already been made to the value of these foods in the economical production of pork. Potatoes are the most valuable of them—400 to 500 lb. being worth about 100 lb. maize or fine middlings. It has generally been held that they should be cooked before being fed, but recent experiments cast doubt on this point, as good results have been got by feeding them raw. Certainly a limited amount of potatoes and roots of all kinds may be fed raw to pigs with great advantage. Of the forage crops, pigs appear to be fondest of rape, which has been found to give excellent results.

Preparation of Food.—Many experiments have been conducted to test the effect of preparing food by grinding grain into meals, cooking, and steeping in water, and feeding as a slop, compared with dry feeding. We cannot in the space at our disposal enter upon these in detail. Put briefly, they indicated that cooking is an unnecessary expense, grinding is desirable, steeping grain 12-24 hours is nearly as good. If care is taken to regulate the water in slop feeding, dry feeding seems to be no great advantage. The chief objection to slop feeding is that unskilful feeders are apt to use too much water. This is a serious mistake, especially in cold weather and for fattening pigs. The drawback of dry feeding is that it is much more difficult to carry out without waste. Regarding the merits of hot and cold food, unless a supply of hot water can be got at very little expense the advantages of warm food appear to be so small that it is not necessary during the greater part of the year to feed food warm; but in the very cold weather it appears to be worth doing, particularly for nursing sows and young pigs.

In conclusion, we may summarise some of the leading points on feeding put forward here, and which are supported by well-authenticated experiments, namely:—

1. It will not, as a rule, pay to cook food for swine.
2. As pigs grow older and heavier there is a gradual increase in the quantity of food required to produce a pound of increase, therefore swine should be fed continuously so as to make good progress, and slaughtered, as a rule,

by the time they weigh 200 lb. live weight. Ordinarily such pigs should yield 75 per cent of carcase.

3. Grain should be ground and soaked in water 12 to 24 hours before feeding. Whole grain is frequently voided without being digested.
4. A meal made of mixed grains is more economical than one derived from one grain.
5. Succulent vegetable food is necessary, along with meals, to give the best results; and meat- or fish-meal up to 10 per cent of the diet is a very valuable addition to the food of pigs.
6. Milk is not essential to successful pig rearing and feeding, but it adds materially to the value of a grain ration, and gives the highest return when used in small quantities.

NOTE ON THE COMMERCIAL ASPECT OF PIG FEEDING.

By ROBERT WILSON, Barrhead.

In recent years a good deal of attention has been given to the subject of pig breeding and feeding generally, and many articles of first-rate importance have been written dealing with the subject from the breeders' and feeders' point of view. Very little guidance, however, has been offered to the producers regarding the type of pig to be aimed at, viewed from the standpoint of the bacon curer, whose desire is to meet and to satisfy the requirements of the consuming public.

It is a foolish and costly undertaking to try to educate the public in the matter of its tastes, particularly in foodstuffs. The consumer has distinct likes and dislikes, and one of his dislikes is fat bacon. No amount of persuasion on the part of the retailer, however eloquent he may be, will coax any one of his customers into relishing fat bacon if he has no desire for it. He may be induced to buy it for the time being, to save disappointment to the seller, but when he is again in the market, he will go where he can get what he relishes, even if he has to pay a considerable premium for it.

There was a time, not so very long ago, when home-fed and home-cured bacon could always command a premium over the imported article, and on its merits the premium was not misspent, but it is not always so to-day.

Continental and other producers, catering for our trade, have studied closely the requirements and tastes of the British consuming public, and have bred and fed their hogs with the distinct aim and object in view of supplying exactly what is wanted. They know that the consumpt of any article of food is exactly in proportion to its popularity, and knowing that, they have set themselves to provide our market with that which is in request. These competitors also know that some pigs grow faster and fatter than others, and in order to maintain a high standard of excellence and price for their first selection, they classify their bacon as to weight, quality, and fatness, and the price is arranged accordingly; consequently, a buyer knows exactly what he is getting. In Scotland, with few exceptions, pigs are sold indiscriminately—fat and lean, light and heavy together; and while a certain amount of classification is neces-

sary when the bacon is being marketed, it is not nearly so perfect and reliable as it ought to be. The result is, that the consumer does not now pay a fraction of the attention he formerly did to the nationality of his bacon in comparison with the care he gives to its being lean and of good quality. With characteristic short-sightedness, the average farmer thinks of his immediate profit, which may be greater from quickly fed, short, thick pigs; but he forgets that the industry, so far as the home supply is concerned, is in his care and keeping, and that it can be maintained and improved only by directing his energies strenuously towards supplying that for which the consumers are prepared to pay the higher price.

It is always a mistake to argue with the consumer. Give him what he wants every time. It will pay handsomely to yield to his demands, and at the same time will be doing only what our competitors, with more foresight, have done long ago, and for which they are now reaping the reward.

One of the beneficial results of the War in which we are presently engaged has been the revelation to the British Government and to British manufacturers of our lamentable unwillingness to adjust ourselves to the requirements of our customers, thereby playing into the hands of our competitors, who, having seen our absolute stupidity in the matter, have with much success set themselves to capture the trade lying at our own door.

This failure on our part is nowhere more apparent than in the pig and bacon industry, proof of which is to be found in the ever increasing imports of ham and bacon from pigs bred, fed, and cured to meet exactly the fastidious tastes of a contented British public.

The home-bred and home-fed pig has been living in exile and oblivion for a long time. Being of retiring habits, he has accepted submissively the place assigned to him by the unconscious promoters of foreign industry,—county councils, sanitary authorities, &c.

Things have suddenly changed in his favour, and now, as a result of the operations of the German submarine, the conditions and byelaws of the "Medes and Persians" type, under which he for long lived a neglected and isolated existence, have been of necessity relaxed.

In the public press he is being advertised and encouraged, coaxed and coddled, even by men of literary talents, who, once upon a time regarded him as only deserving of the fate which, as narrated in Bible history, befell two thousand of his brethren, who, devil-possessed, "ran violently down a steep place into the sea and were drowned."

The purpose of this article is not to advocate any particular

breed of pig, but to indicate the type that is desirable from the consumer's point of view, in the hope that farmers and others will in the future, more than in the past, seek to provide the home market with the class of bacon for which there is almost an unlimited demand.

The desirable pig should weigh, dead weight, from 150 to 160 lb. It should be of good length, and, while showing evidence of being well fed, must be lean. The neck and shoulders must not be too thick or heavy, these being the less desirable parts and inclined to take on fat; the middle should be long and the ribs well sprung, with the lean well developed along the back; the belly and flanks should not be too deep or heavy, and the hams or gammons should be in proportion to the whole.

The Ayrshire method of curing and marketing bacon does not lend itself to the same distinctions in cut, and consequently does not afford the same variation in price as does, say, the Wiltshire cure. Bacon dressed in the Wiltshire style is dry cured, in sides, and is sold in cuts of great variety. The choicest cuts make in some cases almost 100 per cent more than the least desirable parts. On the other hand, bacon handled in the Ayrshire style, after being skinned and boned, is cut into quarters, cured in pickle, and then formed into rolls, each roll containing half a side of bacon. It will thus be observed that this method of marketing prevalent in Scotland does not afford opportunity for so much variety of price as applies to the Wiltshire style.

The outstanding fact remains, attested by many years of practical experience, that no matter what the style of cut or cure may be, the public will always consume in much larger quantity, and at a considerably increased price, bacon that is lean and well fed. No producer of bacon can afford for long to oppose or even attempt to educate public taste in the matter of its breakfast diet; and the sooner we recognise this, and get into position to meet the after-war conditions, which we dare not shirk, the better it will be for all concerned.

INSECT AND ARACHNID PESTS OF 1916.

By R. STEWART MACDOUGALL, M.A., D.Sc., F.R.S.E., Consulting Entomologist to the Society.

LICE ON MEN.

In last year's 'Transactions' I gave full notes on the Clothes or Body Louse of man, and recommended, from its proved usefulness, a powder known as N.C.I. powder, with the formula —naphthalene, 96 parts; creosote, 2 parts; iodoform, 2 parts. I have received further testimony to the value of this powder, and recorded experiments[1] are very favourable as to its insecticidal value. The N.C.I. powder should not be exposed in perforated tins, as its use in this way is not successful. The powder, which is dusted on underclothing and along the seams of tunics and breeches, should not be used too freely, as a skin irritation is apt to follow.

The louse problem is one not confined to home or to the Western Front, but has exercised the authorities in all the countries at war, and French, Italian, Russian, Dutch, and German scientific literature contains many references to it. I mentioned last year benzine and paraffin as substances which killed lice. In Italy[2] both of these have been used against the head louse for soldiers in the field. Too heavy applications of benzine resulted in headache, while there is a risk of skin lesions and poisoning from the vapour. Paraffin or petroleum, a very common remedy against these lice, is safer and better to use (apart from risks of fire).

From inquiries and reports made to me, men find that in war conditions some protection against infection by lice is necessary, and it may prove helpful if attention is called to a comparatively simple device described by Captain Gunn.[3] Under-vests are made of that light material known as butter-muslin. These are then dipped in a solution made of—

Second grade petrol	1 gallon.
Naphthalene	1½ ounce.
Sulphur	1½ ounce.

[1] 'British Medical Journal,' 3rd June 1916, pp. 784 and 789.

[2] 'Annali d'Igiene,' Rome, April 1916, p. 268 (see 'Review of Applied Entomology,' vol. iv. Ser. B, July 1916, p. 104).

[3] "A Note on the Prevention of Pediculosis," by Captain J. A. Gunn, M.A., M.D., D.Sc., R.A.M.C., 'British Medical Journal,' May 5, 1917, p. 579.

The vests, after being dipped in the solution, are wrung out. (The actual cost of the dip, where a number of vests were treated at the same time, worked out to one farthing a garment in 1915, but the ingredients are now dearer.) The vests are so impregnated with the naphthalene and sulphur that the fibre is penetrated. No irritation to the skin attends the wearing of these vests, and much testimony from officers and men has been received "in favour of the high or complete protection of these vests against the body louse." The vests themselves, being made of such light material, do not last very long of course; and at their original cheap cost a vest was worn and then thrown away, and another donned.

It may turn out in further experiment that the sulphur can be omitted. There is some doubt and contradictory evidence as to the value of sulphur used in this way against body lice. The evidence I have myself is contradictory, in spite of a widespread belief that sulphur is very efficient.

Itch or Mange or Scab.

This disease is caused by mites belonging to the family Sarcoptidae. The family is divided into several genera, and in response to requests as to the differences between these genera I append two tables, which I have repeatedly proved helpful in my work. Three generic names are well known to the veterinarian—viz., Sarcoptes, Psoroptes, and Symbiotes or Chorioptes. Each of the three is the cause of a mange of its own, and the same animal may in some cases be affected with all three manges—*e.g.*, the horse, ox, and sheep may suffer from sarcoptic, psoroptic, and chorioptic mange, and the dog and cat from two different kinds of mange. The three mites may be distinguished under the microscope as follows—

Sarcoptes.	Psoroptes.	Symbiotes (Chorioptes).
Body round.	Body more oval.	Body more oval.
A short wide beak.	More pointed beak	Beak obtuse, and as wide as long.
Legs short; the four front legs spring from the edge of the body, and are visible from above; the four hind legs arise from the under surface, and are almost concealed from above by the body when the mite is rest ing or walking.	Legs longer; all four pairs visible from above, as they project from the sides of the body.	Legs long; all four pairs visible from above.

Sarcoptes.	Psoroptes.	Symbiotes (Chorioptes).
The farthest out portion (tarsus) of the leg bears an unjointed stalk, ending in a small sucker.	The tarsus bears a three-jointed stalk with a sucker.	The tarsus bears a short unjointed stalk and a wide sucker.
The mites mine into and make galleries below the skin.	The mites do not burrow, but live in parts sheltered by hair and wool, and under crusts.	The mites live more exposed.

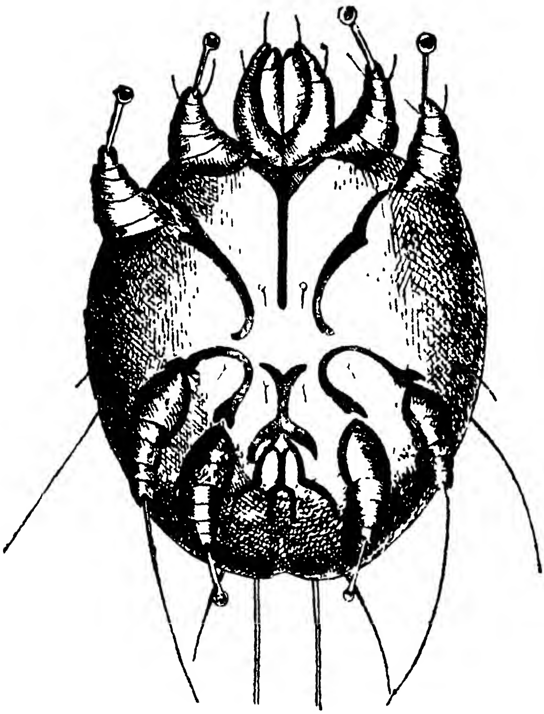

Fig. 15.—Sarcoptes scabiei.

Greatly magnified. (After Lohmann, in 'Das Tierreich.')

In ordinary practice this key will be found sufficient, but the specialist who at the moment has to examine and report on many cases of mange requires a more detailed key to the family Sarcoptidæ. Specialised work on these mange mites has resulted in the genus Sarcoptes being broken up into various genera, and the genus Chorioptes is also sub-

divided. The mange mites being very minute, practically invisible to the naked eye or just visible in the largest species, the key is useless unless the microscope is used.

Detailed Key.

I. Male destitute of copulatory suckers in the neighbourhood of the anus. The two first pairs of legs have a stalk ending in a sucker in both sexes; and in the case of the

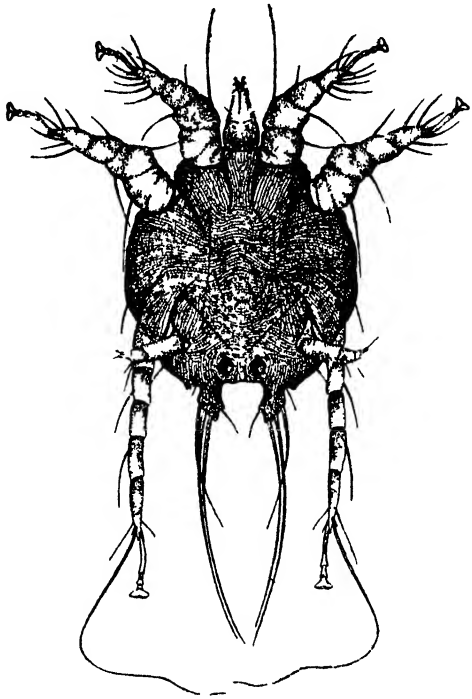

Fig 16.—*Adult male of* Psoroptes communis *from under surface, greatly magnified*

(After Salmon and Stiles.)

male there is a stalk and sucker also on the fourth pair of legs, viz.:—

A. *Sarcoptes*, with the anus terminal. The Sarcoptes mange mites are parasitic on mammals—*e.g.*, the mange mite of man—so troublesome at this time to many of our soldiers—and the Sarcoptes of horse and dog.

B. *Notoedres*, with the anus dorsal. This mange is also found on mammals—*e.g.*, the cat.

II. Male with or without copulatory suckers; the male has stalk and sucker on all the legs, no stalk and sucker on legs of females, viz.:—

The genus *Cnemidocoptes* parasitic on birds—*e.g.*, the cause of scaly leg and depluming scabies

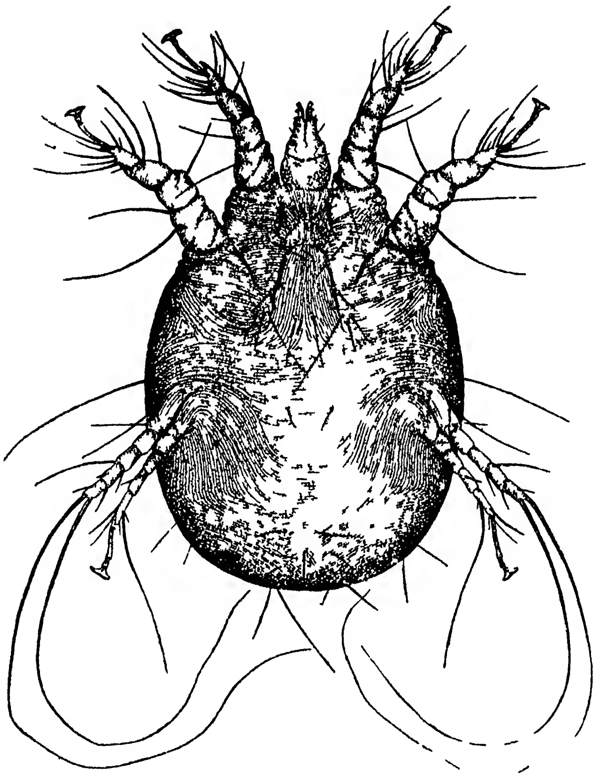

Fig 17.—*Adult female of* Psoroptes communis, *greatly magnified, from under surface*

(After Salmon and Stiles.)

III. Male furnished with copulatory suckers, stalk and sucker present on the legs.

A. *Psoroptes.* Stalk and sucker on the 1st, 2nd, and 3rd pair of legs in the male (the 4th pair of legs is rudimentary or very short). Stalk and sucker on 1st, 2nd, and 4th pairs of legs in the female. The stalk in the Psoroptes mange mites is long and three jointed. The Psoroptic mange mites are parasitic on mammals, the best known and most

troublesome species being the cause of "Sheep Scab."

B. *Chorioptes* (Symbiotes). Stalk and sucker on all the legs in the case of the males; stalk and sucker on 1st, 2nd, and 4th pair of legs in the case of the females. The stalk is short and the sucker wide. The Chorioptic mange mite is parasitic on mammals—*e.g.*, is found on horse, ox, sheep, goat.

C. *Otodectes.* Stalk and suckers on the front pairs of legs in the case of the females. This mange mite is parasitic on mammals, and is the cause of the Otodectic (Chorioptic or Symbiotic) mange of the ears of dog and cats.

At the present time, in war conditions, when mange or itch or scab is common, in some cases very common, it is important to keep in mind how infectious the disease is, and the possibility of the disease passing not only from man to man—as it so readily can do in the Sarcoptic scabies of human beings—but from domesticated animals to man. The Sarcopt of the horse passes readily to ass and mule, and is transmissible to man. In the past year I have seen several such cases. The Sarcoptic mange of the cow can also pass to man, I have also seen cases of this. The Sarcopt of the dog is communicable to man, as is also the mange of the cat

Demodectic or Follicular Mange.

This is a different kind of mange, due to an extremely minute mite which, when isolated and magnified under the microscope, is seen to have an elongated worm-like form. The disease is worst on dogs, and seems practically incurable if before treatment the disease has made progress. I have seen cases where treatment, extended over many weeks, failed in result.

The Demodex mite of man and of domesticated animals other than the dog, does not call for lengthy note, but I wish to record a Demodex case on the horse associated with psoroptic mange of the horse. Scrapings from the withers of a horse suffering from mange had been taken for microscopic examination. In addition to the mange mites a number of Demodex mites were present. This corresponds to observations made by my colleague, Professor Linton, who in 1915 in sarcoptic mange scrapings from horses found and showed me Demodex mites. These cases are interesting, inasmuch as previous records of Demodex on the horse relate to its presence only in the Meibomian glands of the horse, and the muzzle of the horse. In 1916 a case was reported by Urbain from Brazil where a man received Demodex infection in treating a horse suffering from demodectic mange. The

accompanying figure (Fig. 18) shows a greatly magnified Demodex mite; the natural size is roughly about $\frac{1}{100}$ inch. These mites, after pairing, lay their eggs, from which hatch larvæ with six rudimentary legs or tubercles; after a moult the six-footed larva becomes a nymph with four pairs of tubercles. Still another moult results in a stage with developed mouth apparatus and jointed legs. Development of the sexual organs marks the adult stage.

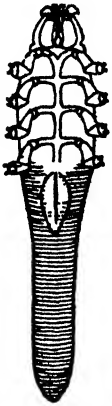

Fig. 18 —Demodex folliculorum.
Greatly magnified. (After Lohmann, in 'Das Tierreich.')

The Harvest Mite or Berry Bug.

Complaints regarding this mite are common in the summer and early autumn. The counties south and east of Mid-Lothian appear from letters and newspaper correspondence to harbour the mites in numbers. The mite, however, is not confined to the south-east of Scotland, but has a wide distribution over the country. The adult mite is a beautiful satiny red creature, with its body divided into two regions, an anterior region (combined head and thorax) carrying the head, mouth-parts, eyes, and two front pairs of legs; and a much larger hind region — the abdomen — which carries the two hind pairs of legs. The general shape of the adult can be seen from the figure (Fig. 19). Under magnification body and legs are seen to be covered with hairs. This adult is not harmful to man, but seems to derive its nourishment from insects. It is the larva which punctures the skin of man and is the cause of such irritation that workers in the field are disinclined for harvest work, gardeners and owners of fruit gardens dare not pluck their own fruit, and holiday-makers cut short their holiday and return to town where these mites cease from troubling. The larva is a six-legged form that hatches from

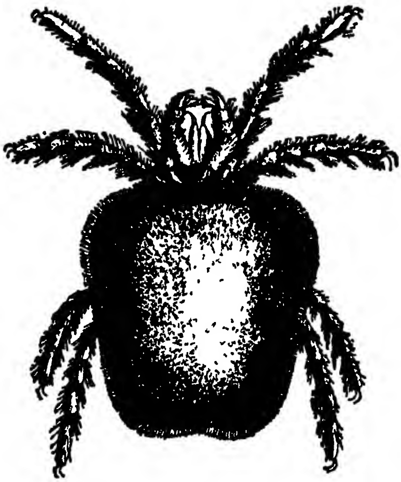

Fig. 19 —Trombidium holosericeum, *female, dorsal surface.*
Magnified 20 times. (After Railliet.)

eggs laid in the ground (Fig. 20). The larva moults several times before the adult stage is attained.

These larvæ swarm in late summer and autumn in long grass, bracken, nettles, gooseberries, currants, raspberries, beans, and from these plants pass to man—women and children are specially sensitive—and to such animals as the rabbit, hare, dog, cat, ox, horse. Attack by the larvæ may persist into mid-October and even later in shady places under trees where frost has not reached.

The larval mites attach themselves to various parts of man's body, creeping under his clothing or down his neck to insert

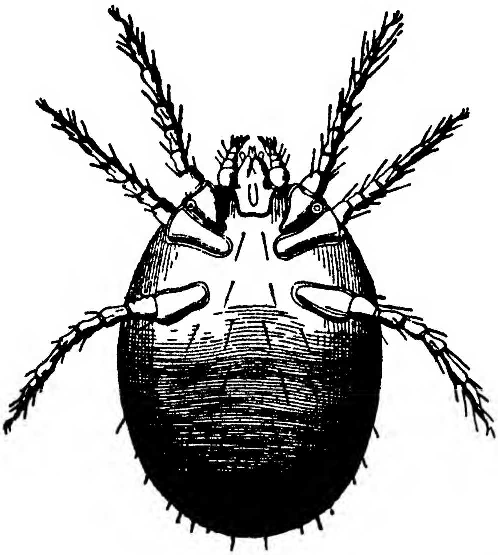

Fig. 20.—*Larva of* Trombidium holosericeum, *ventral surface* Magnified 100 times (After Railliet.)

their mouth parts into the skin, sometimes one here and one there, sometimes a number together. All subjects are not equally sensitive, but smarting, intense itch, reddening and blisters are accompaniments of attack; the skin may look as if stung with nettles. Shipley, in his 'The Minor Horrors of the War,' records an attack of these berry bugs on soldiers living in tents in the neighbourhood of Cambridge; the ankles, wrists, and necks of the men were most attacked. White, in his 'Natural History of Selborne,' says that in the "chalky districts of Hampshire the mites swarmed to so infinite a degree in the rabbit-warrens on the Downs as to discolour the nets of the warreners and give them a reddish tint, while the men were so bitten as to be cast into fevers."

Dogs, especially hunting dogs, harbour the parasites on nose, head, belly and feet. On the cat they give rise to wounds at the root of the tail, and on the feet between the claws. Dr Johnston, in the 'History of the Berwickshire Naturalist's Club,' quotes a correspondent as to this mite thus: "In the worst case I have ever seen, that on a horse, the skin seemed exactly as if it had been rubbed with a liquid blister." In Continental and American literature chickens and fowls are named as being much annoyed by the harvest bugs, which fix themselves at the base of the feathers and bury their mouth parts in the skin.

Fig 21 —*Larval gallery of* Magdalis phlegmatica *on Scots Pine*

From nature Natural size

I have written of the Berry Bug without going into the debated and unproved question of the number and identity of the species of culprit.

Treatment.—As a protection, some try sulphur dusted down the inside of their stockings.

Irritation is relieved by a salt-water bath, or by bathing in water to which ammonia has been added, this last is certainly effectual. If a bath cannot be taken at once or soon, touching the itchy and smarting part with ammonia is effective In absence of ammonia a hot-water bath with abundance of soap gives relief.

MAGDALIS PHLEGMATICA. Hbst.

Magdalis (Magdalinus) is a genus of weevil concerning which not very much information exists as to life-history and economic importance Specially is this so with regard to the forest species, which need more detailed study than they have received. On three occasions, from the north of Scotland, examples of the damage done by the Magdalis larvæ on conifers have been sent to me. Of these I have chosen for figuring examples of pine branches given me by Mr James Fraser, B Sc. One of the figures (Fig. 21)

shows the gallery made below the bark by the grub of *Magdalis phlegmatica*, and the other (Fig. 22) shows the flight hole bored from the place of pupation to the outside, when the adult beetle made its exit.

Magdalis phlegmatica lays its eggs on pine and spruce, choosing the tops of old trees. The larva, on hatching, begins to gnaw a gallery below the bark, in the bast region; this gallery increases in diameter with the growth of the grub, and when examined is found to be full of frass and bore-meal. This is brought out in the figures. The grub may bore right into the pith of a young branch and here pupate, the beetle eating its way to the outside when ready. I have specimens of branches over an inch in diameter tunnelled right to the centre. Magdalis may be found working in association with other conifer insects.

Fig. 22.—*Exit hole of* M. phlegmatica.

From nature. Natural size.

The beetle measures ⅛ inch; it is blue-black or green-black in colour, with the wing-covers dark blue; the snout is as long as the thorax, and at its base are staring eyes. Thorax longer than broad, and with distinct punctures. Wing-covers wider behind, with lines of punctures; the interspaces between these are broader and marked with rows of punctures. The male is recognisable by the specially hairy three last segments of the abdomen; the hairs on these segments stand somewhat upright. The larva is a typical weevil grub, whitish, wrinkled, and legless, with horny brown head and biting jaws.

The Pine Beetle (*Myelophilus*, or *Hylurgus piniperda*).

Every year this pest and examples of its work come to me with unfailing regularity—this year specimens being received on pine and spruce and larch. The general habits of this beetle are well known, but the details of its life-history are not so well known. The damage done is twofold. First, the beetles, on issuing from their brood places below the bark, make their way to the youngest shoots at the summit of the trees; into these they bore for the purpose of feeding. As a result, the tunnelled shoots are blown down in hundreds. The young shoots of the pine are made use of for feeding purposes at

two different times in the life of the adult beetle. The young beetles that have developed from pupæ eat their way through the bark to the outside and fly to the young shoots, which they enter, not for brood purposes but for feeding. Dissections of the female reproductive organs of *H. piniperda*, made by Continental workers, in newly issued young beetles, revealed the fact that the beetles were not able at this stage to proceed to an efficient copulation, as their reproductive organs were not ripe. To ripen these organs, and to obtain reserve enough to supply the eggs, a certain amount of feeding requires to take place, hence the visit to and stay in the young shoots. Mr Walter Ritchie, B.Sc., of Aberdeen University, researching in my laboratory on an allied beetle, incidentally and for comparative purposes, has verified the results of the German entomologists regarding *piniperda*. Further, it was found that these pine beetles did not die after producing one brood, but that they were able to proceed to a new pairing and a new egg-laying. This rearing of a second brood by the same parents, however, necessitates a second feeding period, for, after laying the eggs, from which later a brood developed, the mothers are exhausted; and in order to recuperate and renew and refurnish their egg-tubes and become capable of proceeding to a new egg-laying in new-made mother galleries, a certain amount of time has again to be passed in feeding. Mr Ritchie has also verified the Continental work on this in the case of *piniperda*. Of course the whole of the original parents do not proceed to a new egg-laying, for there is always some mortality, and the mortality may be considerable. Sometimes the mothers are found dead at the end of their tunnel after laying eggs for the first time, and by no means do all the rest that come out and proceed to feed again in the young shoots survive to raise another brood. It is interesting to note that the fact of time being required by the adult beetles to feed before multiplication prevents the likelihood of two generations of *piniperda*, in the succession parents, children, grandchildren, in a single year.

The tunnelling of the young pine shoots and the loss of these owing to wind, means in the end a great loss of wood increment, and it is in this way that *piniperda* does its chief damage. So numerous may the *piniperda* beetles be, that the ground below the trees may be littered with hollowed young pine shoots, making it possible for the observant forester to recognise the damage a long way off, for the trees look, as I have pointed out in an earlier description of this beetle in the 'Transactions,' as if they had been pruned by a forester who did not know his business. While such badly damaged trees may be found throughout a wood, the misshapen crowns (the spoiled pines

may come to look like Christmas trees) are most numerous and most evident along the edges of woods.

The ravages of this pine beetle do not end with the destruction of young shoots, but considerable harm is done owing to the brood-galleries. The mature beetles enter the bark of the stem, and the female beetle makes a longitudinal gallery—often with a marked resemblance to a golf club—in the bark or between the wood and the bark. Along the sides of this gallery eggs are laid, and the grubs on hatching gnaw galleries that run more or less at right angles to the parent gallery. These various galleries destroy considerable parts of the cambial region; where the beetles are numerous brood galleries may run together, the tree is ringed, and death follows.

Trees in perfect health are not nearly so exposed to danger as sickly trees weakened by some preceding insect attack or by fungi, and often the beetle makes use—for brood purposes—of almost dying trees, and of the stumps of felled pines.

Cryphalus abietis.

This is a minute beetle belonging to the Scolytidæ, a family of bark and wood borers. The chief host plant of this species is Spruce, but other conifers may be used for brood purposes. The beetle has come to me from Nairn not only in Spruce (*Picea excelsa*), but also on the Noble Silver Fir (*Abies nobilis*). A research on this insect is being carried out in my laboratory.

Insects injurious to Cones and Seed.

For a number of years in succession now, insect-infested Cones of Spruce, Silver Fir, Douglas Fir, and Larch have been brought or sent to me, with requests for information concerning the pests present in the Cones. Such inquiries have an increased importance at this time owing to questions of afforestation and the possibility that in present circumstances a sufficient supply of good seed may not be forthcoming.

Since I wrote some years ago on the Chalcid enemy (*Megastigmus spermo trophus*) of Douglas Fir Seeds, specimens of infested Douglas Fir Seed have reached me from other places. Then, from both Silver Fir Seed and from Larch Seed two further Megastigmus species have been reared. The Silver Fir Cones and the Larch Cones were brought to me by my colleague, Mr J. M. Murray.

Perrisia (Cecidomyia) strobi.

This is a minute delicate fly whose maggots are injurious to the seed of Spruce. Every year since 1910, Spruce Cones in-

fested with this maggot have come to me, and from Spruce Cones collected in Kincardineshire and Perthshire, and right north to Nairn and Ross, I have bred out many hundreds of adult males and females, and also a set of parasites. In the laboratory these adults began to come away in April favoured by the warmth of the room, and issue continued right through May and June.

More Cecidomyid species than one infest Spruce, but *Perrisia strobi* is the one that lives in the Cones. The eggs are laid in the young Spruce Cones, and the larvæ feed on the seed, giving the seed a characteristic shrunken appearance. The larva is a tiny reddish-coloured maggot, legless, and with a characteristic chitinous "anchor-plate" or process just under the head end. The full-fed larvæ pupate in the cones under cover of a very delicate cocoon; groups of three and four such cocoons may be found under the cone scales.

There is a record from the seed-control station at Tharaudt, Saxony, of 15 per cent of a sample of Spruce Seed showing the shrivelled appearance due to *strobi* attack. In different samples examined by myself the percentage of damaged Spruce Seed was still higher.

I have also received from a Forres correspondent many Larch Cones with their seeds infested by the red-coloured maggots of another Cecid. In some of these cones 50 per cent of the seed was injured. The widespread infestation of the Larch Cones by this Cecid was very striking. I tried to rear the adult, but I had taken the cones at rather too early a period and no adults were got. Larch buds are often spoiled by a Cecidomyid larva, and as these larvæ have been found on the Continent in the flower-buds of Larch as well, it is just possible that the culprit was the Continental species. I hope to rear the adults at a later date. The larvæ in the Larch Cones were not *strobi* larvæ, the "anchor-plate" being different in pattern.

TORTRIX STROBILELLA L. IN SPRUCE CONES.

This is another enemy of Spruce Cones and Seed, and in some localities is an insect of distinct importance. I have bred out many hundreds of this species from cones received and collected in various years from September onwards to the early spring. The insect is common in counties north of the Forth, where it interferes with the seed harvest, and is found also in the southern counties of Scotland and in England.

The moth is a small one, with a spread of wings up to and slightly over half an inch. The head is dark and the antennæ black; the front wings are olive-brown or brown with a golden lustre, and have well-marked orange scales and white streaks.

The hind wings are purple-brown or grey. The fringes of the front wings are grey, and of the hind wings white.

The larva is a sixteen-legged caterpillar measuring $\frac{2}{5}$ to $\frac{3}{5}$-inch when full grown. It is white or yellowish white, with

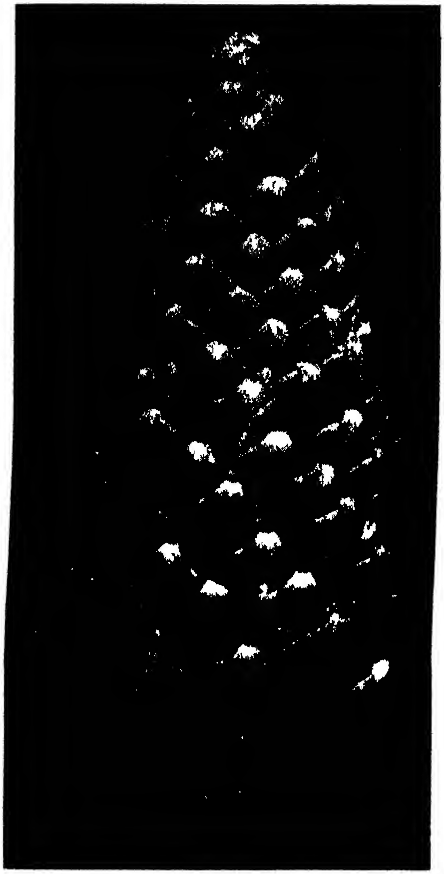

Fig. 23. *Spruce Cone, showing a number of pupal cases from which* T. Strobilella *has issued.*

From nature. Natural size

Fig. 24.—*Spruce Cone infested by caterpillars of* T. Strobilella, *and with the scales bitten off by squirrels.*

From nature. Natural size.

brown spiracles; the head and shield behind the head are pale brown.

After pairing the females lay their eggs in May and June on the cone scales. The caterpillars, on hatching, pass to the centre of the cone and eat into the axis of the cone, destroying

it before it has become hard; the cone scales may be gnawed, but the damage to the scales themselves is not so great as with another Spruce Cone enemy, *Dioryctria abietella.* The seeds are also sometimes eaten. *T. strobilella* spends all its life as egg, larva, pupa, in the cone. The caterpillars feed during the summer and early autumn, and then pass the winter in the cone, pupating in the next late spring. Before the adult moths issue the pupæ push themselves out between the scales, as in Fig. 23. Infested cones appear shrunken, and there is a characteristic exudation of resin.

Fig. 24 shows a Spruce Cone that had been badly infested with the caterpillars of *T. strobilella.* Quite a number of cones resembled this one; the cone scales had been pulled off by squirrels in search of seeds, but they were also eating the larvæ and pupæ of the moth. Similarly squirrels watched in the south of Sutherlandshire have been found ringing the bark of sickly Scotch Pine and feeding on the grubs of the Pine Beetle.

Where *T. strobilella* is plentiful and at work, the attacked cones should be collected, and after any seed worth saving has been saved the cones should be burned with the enclosed larvæ. This could be done from autumn onwards; with infested cones kept in the laboratory over the winter I have never had the moths coming away before April.

From the Spruce Cones I have a mass of parasitic material which I hope to work up after the war.

The following short table will enable one to run down the commoner enemies of Spruce Cones and Seed in Britain:—

I. Axis of cone and cone scales eaten, and the seeds eaten from the outside.

1. Cone axis hollowed out, base of scales gnawed.
   Caterpillars of *Tortrix strobilella* (for description of caterpillar see above).
2. Cone scales badly destroyed, large pieces being eaten away, so that the cones have a ragged appearance.
   The caterpillars of *Dioryctria abietella.* These caterpillars can be distinguished from those of *strobilella* by their greater length when full grown, their brown-red colour and their bristle-bearing warts.

II. The seed is destroyed internally.

1. Seed shrunken.
   The larvæ of *Perrisia strobi,* which are red-coloured, and have an anchor-process.
2. Seed with a white or a yellow-white larva.
   The larva of *Megastigmus strobilobius.*

THE SMALL ELM BARK BEETLE (*Eccoptogaster* (*Scolytus*) *multistriatus.*)

In specimens of bark cut from sickly Elms in the middle of England, in addition to the larvæ and adults of the Large Elm Bark Beetle which had spoiled the trees, many examples of the Small Elm Bark Beetle were present. These two beetles are often found working together. The Large Elm Bark Beetle asks for a better quality of food—*i.e.*, a tree not almost dead; whereas the Small Elm Bark Beetle will attack and rear its brood in poorer material. I have experimentally reared the Small Elm Bark species from Elm logs that were somewhat dry when offered to the beetles for brood purposes.

E. multistriatus measures only 3 to $3\frac{1}{2}$ mm. in length, as compared with the 4 to 6 mm. long Large Elm Bark Beetle, hence the mother gallery and larval galleries have a smaller diameter. The larval galleries of *multistriatus* are also more numerous, and are closer together.

The Small Elm Bark Beetle is black or dark brown (the young beetles are light brown and the newly-formed beetles light-brown-yellow with glossy heads), the antennæ and legs being paler. The thorax is longer than broad and very finely punctured, the punctures on the flat part being finer and not so close as those at the sides. The wing-covers are brown, somewhat narrowed behind, and have many punctured striæ. From the posterior margin of the second abdominal segment there projects a moderately long, strong spine, backwardly directed. In the male the forehead is somewhat compressed, and bordered at the sides and behind with greyish-yellow bristles. In the female the forehead is somewhat arched, and lacks the bristles.

The female gnaws out in the cambial region a gallery that runs longitudinally. The gallery cuts into the outermost youngest wood ring, and varies in length—$1\frac{1}{8}$ inch, $1\frac{1}{4}$ inch, 2 inches being lengths in my experiments. In shape the gallery suggests a miniature golf-club, the head of the club marking the place of entrance and start. The mother cuts notches along the sides of this gallery for the eggs. The grubs which hatch tunnel at right angles to the parent gallery, but after going some distance the tunnels bend upwards or downwards. Some of the tunnels measured $2\frac{1}{2}$ inches in length. The larval tunnels may be chiefly in the bark, but where the bark is thin they can be traced on the outermost wood rings. The full-fed grub pupates in an oval bed hollowed out in the bark, and the beetles when ready bore out through bed and bark, the flight-holes on stem or branch resembling a number of small shot-holes.

My experience of this beetle leads me to look upon it as a

late swarmer. In my experimental notes, in a certain year, I got 144 beetles on July 1, and issue from the trees continued in increasing numbers till July 16. In another year, July 15 was the earliest date on which new beetles issued from my

Fig 25 —*Leaves of* Quercus ilex, *lower and upper surface ruined by caterpillars of* Lithocolletis messaniella

From nature Natural size

experimental logs In still another experiment, from a sleeved log on which beetles were put towards the end of July of one year, the first of the new brood made its exit on July 15 of the next year, escape from the log continuing on through July to the end of August.

E. multistriatus alone and unaided is not a formidable enemy of an Elm tree, but in conjunction with *E. destructor,* and seconding its work, the Small Elm Bark Beetle may have considerable importance.

LITHOCOLLETIS MESSANIELLA Q. ON HOLM OAK.

Lithocolletis is a genus of Tineid Moths whose caterpillars mine in the leaves of broad-leaved trees and some shrubs and herbs. The genus has many species, and at least nine in Britain use oak as their host plant. Fig. 25 shows leaves from Evergreen or Holm or Holly Oak (*Quercus ilex*) that have been mined and blotched by the caterpillars of the above species. The specimens are from Fife, and from a tree which in September had nearly all its leaves spoiled by the caterpillars. At a considerable distance from the tree one's attention was drawn to it by reason of the characteristic damage, the dark-green polished appearance being replaced by hundreds of pale-coloured blotches.

WOOD WASPS (SIRICIDÆ.)

The Giant Wood Wasp (*Sirex gigas*) and the Steel-Blue Wood Wasp (*Sirex noctilio*) were both sent to me during the year. The first of these two insects is sent to me every year, generally the females; doubtless their large size and striking appearance call attention to the insect. The females are easily recognised by the boring ovipositor projecting from the hind end of the body (Fig. 26); from the tip of the abdomen above the ovipositor there also projects a short spine. The females, in spite of their formidable appearance, are quite unable to sting. The larvæ (Fig. 27) live in the solid wood of trees; they are white or whitish yellow, with rounded bodies, and have small horny heads, with mandibles fitted for gnawing; there are three pairs of stunted thoracic feet; the last segment ends in a horny spine of use to the larva in its progression through the wood.

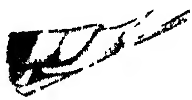

Fig. 26.—*End of abdomen of female* Sirex gigas, *the giant wood-wasp, showing spine and ovipositor.*

Natural size. From nature.

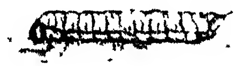

Fig. 27.—*Grub of* Sirex noctilio. From nature.

The Giant Wood Wasp (*Sirex gigas*) chooses Spruce for its egg-laying, but uses also Silver Fir, more rarely Pine and Larch. My colleague, Mr J. Lyford Pike, has recorded *Sirex gigas* from the Douglas Fir and from Japanese Larch. The

sexes not only vary in size, but there is considerable variation in size in the same sex. I have females varying from less

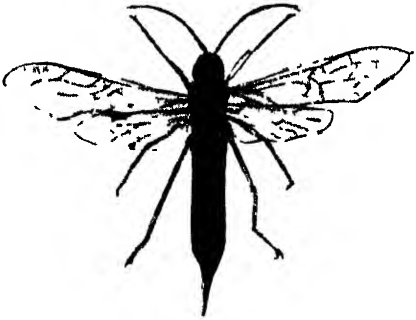

Fig. 28.—Sirex noctilio, *female*

Natural size. From nature.

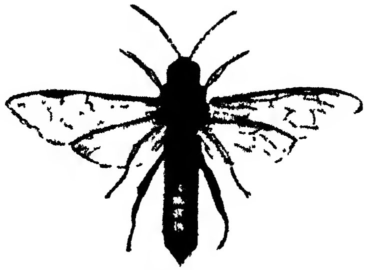

Fig. 29.—Sirex noctilio, *male*.

Natural size. From nature.

than an inch up to 1¾ inch (including the ovipositor), and males from less than an inch up to 1¼ inch in length.

The Steel-Blue Wood Wasp is also found over Britain and in Ireland. The scientific name should, as Morice has pointed out, be *Sirex noctilio*, instead of the commonly used name *S. juvencus*. The true *Sirex juvencus* is rare in Britain. The Steel-Blue Wood Wasp chooses Pine for its egg-laying, sometimes Spruce, on occasion Silver Fir. I have females from less than an inch up to 1½ inch long, and males from ¾ inch up to 1⅛ inch long.

Fig. 30.—Sirex noctilio *in the act of eating its way out of pine-stem after pupation.*

Natural size. From nature.

The larvæ of the wood wasps, by their galleries, spoil the wood for technical purposes. Not only are sickly suppressed standing trees used for brood purposes, but eggs are laid freely in broken, blown, and felled timber. Felled or blown trunks should not be left lying in the wood, as they are used for brood purposes, and act as centres from which the wood wasps pass to standing trees.

In reply to questions, I contrast the two common species, with a note on the third, following Morice:—

SIREX GIGAS.	SIREX (MELANOCERUS) NOCTILIO.
Male usually larger than in noctilio.	
Antennæ of male yellow.	Antennæ of male black.
Abdomen of male dull.	Abdomen of male shiny.
Abdomen of female with the first two and the last three segments yellow, the other segments black.	Abdomen of female steel-blue.
3rd joint of antennæ, if anything, shorter than the 4th.	3rd joint of antennæ distinctly longer than the 4th.

The true *Sirex juvencus*, F., Morice says, is rare, and has the following characters: "Antennæ widely yellow at the base; the upper flattened portion of the head finely punctured and

Fig. 31.—*Flight holes of* Sirex gigas *on Japanese Larch.*

From nature.

not deeply furrowed; the female has all the legs red up to the coxa or top joint. In the male the 8th dorsal segment is blue only at the sides."

There is another genus of Wood Wasps—viz., the genus Xiphydria—easily distinguishable from Sirex by the fact that the head is seated on a long neck-like prolongation of the front part of the thorax, as indicated in the names of the two species, *X. dromedarius* and *X. camelus*. The Xiphydria species attack

broad-leaved trees, not conifers. They are not found in Scotland, but from a large section of a full-grown willow stem received from England I reared a large number of *X. dromedarius*.

Fig. 32.—*Stem of* Pyracantha lelandi *showing collections of frass of caterpillars of* Semasia woeberiana

From nature. Natural size

The Cherry- and Plum-tree Borer (*Semasia* or *Enarmonia woeberiana*)

This is a moth which is found over England and in the southern counties of Scotland. I have records in my notes of damage done by its caterpillars to peach, cherry, pear, and a

decorative plant, *Pyracantha lelandi.* In one of my specimens, an attacked cherry, the presence of the Semasia caterpillars was attended by a very marked gummosis. All my records are English ones, and I have wondered that no complaints have been made in Scotland; perhaps because (there is a Mid-Lothian record of long ago) the damage is not recognised, and ascribed to something else.

The moth is a pretty one, and would attract the attention of a lepidopterist, but the owner of rosaceous fruit-trees should recognise the species from the injurious and characteristic work of the caterpillars. The eggs are laid low down on the tree—in the specimens that have come to me—from 6 inches above the ground to 4 feet 5 inches high; the caterpillars feed on the bast, and attention is drawn to their presence by the little heaps of frass, which are pushed to the outside and remain in little collections (Fig. 32) or drop to the ground below. Theobald, in his 'Insect Pests of Fruit,' writes: "The caterpillars are dull pinkish-white to pale dusky-brown, with a dark bilobed head and two large median and small lateral dusky tubercles on the first six segments, a simple hair arising from each; on the four following segments are two small extra dorsal spots behind the two large ones, and the tail end is darker than the rest of the body. In length they measure a little over ½ inch." The caterpillars are sixteen-legged.

Three signs will suggest the presence of this enemy: (1) the dying off of the infested branch or stem; (2) the little heaps of excrement on the bark; (3) the empty pupal cases projecting from the place of attack.

THE APPLE MUSSEL SCALE (*Mytilaspis pomorum*, or *Lepidosaphes ulmi*).

Specimens of this scale were sent this year on apple from Mid-Lothian. A full account of the insect is given in the 'Transactions' for 1915. Apple growers should be on the look-out for this enemy, which does not confine its onsets to apple, but infests other Rosaceous fruit-trees and a large number of plants differing widely in relationship — shrubs, broad-leaved trees, coniferous trees.

THE MAGPIE OR GOOSEBERRY AND CURRANT MOTH (*Abraxas grossulariata*).

This species continues to prove itself a severe enemy, especially in gardens of gooseberry and currants. Complaints come regularly in April (Cornwall) and May of the damage

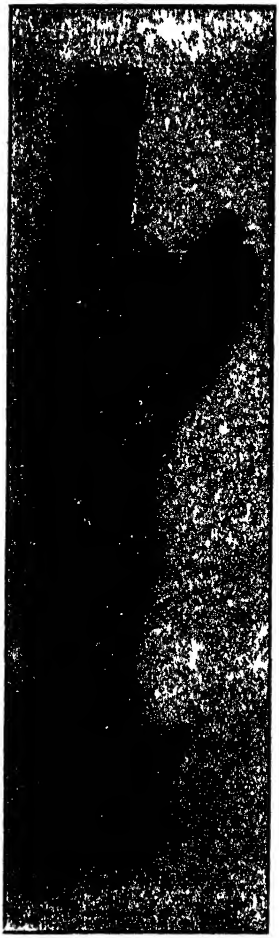

Fig 33 —*Branch of apple tree covered with apple mussel scale*

From nature Natural size

Fig 34 —*Branch of apple tree covered with apple mussel scale*

From nature About 4 times magnified

done by the caterpillars The caterpillars use a number of different plants in their feeding—*e g*, blackthorn, hazel, Euonymus—but prove themselves specially troublesome on gooseberry and currants, whole bushes being stripped of their leaves in a very short time One of my correspondents wrote, in late autumn "It will interest you to know that the hazels in the hedgerows here (South Wales) are infested with the young larvæ of *Abraxas grossulariata*, they are present in

thousands." Another correspondent found that the Magpie Moth caterpillar fed on his Euonymus japonica, and did not attack his gooseberry or currant plants.

One of the weak points in the efforts made to contend against the Magpie Moth caterpillars is that the life-history of the insect is not sufficiently understood, with the result that spraying and other measures are undertaken too late. A knowledge of the round of life of an insect often reveals that there is a vulnerable stage when destructive measures are likeliest to meet with success. That this is the case with the Magpie Moth will be understood from what follows. The caterpillars do not complete their growth in the same year in which they are hatched, but live over the winter to complete their feeding and growth in the next spring. The moths are found flying in July,—in 1916, in Forfarshire, I found the moths coming away from the chrysalids from the third week of July onwards,—and from eggs laid then and in August tiny caterpillars hatch. These caterpillars, being small, do not eat so voraciously as they do after their winter's rest, and they eat for a very short time; besides, they are feeding on leaves which have done most of their work and will soon be falling off. It is now, when this warning is given, and during the winter when the young caterpillars are hibernating under cover of leaves spun together, or in the soil or litter below and adjoining their food-plants, or, in the case of bushes against walls, in cracks in the walls, that the pest can be fought with some success. Even if nothing is done against them at this time, it is of service if the young caterpillars have been observed, for then, very early in the next spring, they will be expected to return to the plants, and they can be destroyed before they do much damage. Far the commoner thing to happen is that the caterpillars are not observed in the autumn—or, if they are, they are not recognised as the young stage of the troublesome spring enemy,—and they have often done much damage in spring before any measures are taken against them. This delay in offensive measures is the more unwise, as the caterpillars are not only larger and greedier, but they are destroying the leaves developed at the expense of the reserve in the plants, before these leaves have had time to earn anything for the plant—*i.e.*, the plant, deprived of feeding organs on whose activity fruit formation depends, is still further weakened by the drain on it in having to develop a second set of leaves which may also be destroyed.

The Magpie Moth varies a good deal in colouration according to the kind of food-plant on which the caterpillars have been reared; but in typical specimens the head is black, the antennæ are short, the body is yellowish, with a black spot

on the upper surface of the fore body and a row of black spots along the back; the front wings show a number of black spots on a white or yellow-white ground, with orange blotches; the hind wings are white, with black spots round the edge and here and there over the surface. There are dark and light varieties of the moth. The caterpillar is a looper or Geometer, with ten legs. It is cream-coloured, with a row of squarish black velvety spots down the middle of the back; the spiracular line is reddish orange with rows of black spots above it and below it; spiracles black; head black, with a few hairs. There are three pairs of thoracic legs, black in colour, and only two pairs of abdominal or prolegs, one of these pairs being borne by the very last joint. There is a very dark variety of this caterpillar which is sometimes sent. The full-grown caterpillar measures 1½ inch.

The pupa is black, with three complete yellow rings, and others incomplete. The pupæ may be found attached to the plant itself or on walls beside the plants that were infested, and on or in the ground below.

Treatment.—When the young caterpillars have been noticed in autumn the plants should be pruned and the prunings burned; the ground below should be dug deeply after getting a dressing with powdered quicklime. The bushes should be gone over, and loose leaves remaining should be collected, as they may be sheltering the wintering caterpillars.

Careful outlook should be kept for the appearance of the caterpillars in the spring, and handpicking—if the area be small—practised.

The caterpillars are poisoned if the plants are sprayed with arsenate of lead; the spraying should be done whenever the caterpillars are noticed. Bushes in fruit should not be sprayed with the arsenate spray within four weeks of the fruit being collected.

There is a certain amount of natural help from insects parasitic on the Magpie caterpillars. I have bred from infected material parasitic Ichneumonids, and also considerable numbers of a parasitic Tachinid fly.

The caterpillars of the Magpie Moth are nauseous to birds; the gay colour of the caterpillar is a warning and an advertisement in case a bird should make a mistake and wound the caterpillar before dropping it. The cuckoo, however, seems an exception. Professor Newstead examined three cuckoos shot at different times and in different places, and found in two of them many Magpie Moth caterpillars, and in the third, two Magpie Moth caterpillars, and ninety caterpillars of the Gooseberry Sawfly.

THE GOOSEBERRY SAWFLY (*Nematus ribesii*).

The Gooseberry Sawfly is another prevalent insect whose caterpillars are destructive on gooseberry. Although this insect is quite different from the last, belonging as it does to a different Order with a different life-history, yet the two are often mixed up by the ordinary observer, or rather one gets blamed for the misdeeds of both. This is due partly to the fact that the larvæ of both are caterpillars and feed in the same way. Yet a look at the two caterpillars side by side would at once show the difference. With an ordinary low-power hand lens one can count behind the head of each of the caterpillars twelve joints. Comparing the two caterpillars joint by joint the observer would find the following differences as regards legs:—

Species	Joints or Segments												Total
	1.	2.	3.	4	5.	6	7.	8	9	10	11.	12	
Magpie Moth . . .	2 legs	2 legs	2 legs	0	0	0	0	0	2 legs	0	0	2 legs	10 legs
Gooseberry Sawfly	2 legs	2 legs	2 legs	0	2 legs	2 legs	2 legs	2 legs	2 legs	2 legs	0	2 legs	20 legs

If one examines the Gooseberry Sawfly caterpillar a little more closely it will be seen that the two legs of joint 12 are joined at the base, and that there are also two very small projections from the last joint.

In addition to these differences the colour is very distinctive. The Gooseberry Sawfly caterpillar varies during its life; in the newly hatched caterpillar the head is black and the body white or greenish-white, with a dark dot here and there. After a moult, while the head is still black, the body is green, with a large number of dark dots. When nearly full grown the caterpillar has a pale head, the body is pale green except in front and behind, where it is orange-coloured, and there are no black dots.

The Gooseberry Sawfly lays its eggs in April and May on the leaves; in a week the eggs have hatched, and by another month the caterpillars are full fed, and have descended the food-plant for pupation. The pupal changes take place under cover of an oval yellow-brown cocoon; the cocoons are in the soil below the food-plant. In three weeks the adult sawflies may have come from these, and a new brood follows. The cocoons of the last brood of caterpillars lie in the soil over winter, the adult sawflies coming from them in the next April or May.

Treatment.—Arsenate of lead may be used against the cater-

pillars, as in the case of the Magpie Moth. Another spray has the formula: hellebore 1 ounce, water 3 gallons; the hellebore does not dissolve in the water, and therefore the spray fluid should be kept agitated; in order to aid adhesion 2 ounces of flour may be added to the spray fluid. Some prefer a mixture of hellebore powder and fine soot, this being thrown by hand as the operator walks down the rows of bushes.

Hellebore, like arsenate of lead, is a poison, and should not be used within four to six weeks of harvesting the fruit.

Where the caterpillars have been at work in summer the soil below the bushes should be removed for a depth of two inches and replaced with fresh earth and manure. This should be done in winter, the purpose being to remove the cocoons from which the spring adults would come.

THE MEALY PLUM APHIS (*Hyalopterus pruni*).

This is a widely distributed species injurious to plum and apricot. The aphid is found in great numbers on the undersides of the leaves. On June 28 they were in masses on the leaves and shoots of Victoria Plums in Mid-Lothian. The sucking mouth-parts of the insect are sunk in the tissue of the leaf and the sap drained away. The aphids give off a great quantity of a sticky fluid known as honey-dew, and this drops on leaves and fruit; the spores of a fungus germinate on this sweet stuff, with the result that the leaves become as black as soot with the fungus. The leaves are further spoiled by the mealy secretion which characteristically covers this insect and which gets rubbed off.

Hyalopterus pruni is one of the aphids which make use of two host plants of different species in order to complete their life-history. *H. pruni* lives and multiplies on the plum until summer or late summer, when winged virgin females migrate to reeds, hence the other name for this aphid of *Hyalopterus arundinis.* In autumn there is a migration back to the plum. During the whole season, from the spring right up to the return of the aphid to the plum, only females are found, wingless and winged, and several generations have been produced parthenogenetically. Only once in the life cycle are sexual males and females produced, and that is in autumn on the plum. After pairing, the fertilised females lay the eggs which remain unhatched over winter. In the next spring the eggs hatch, giving rise to young forms that develop into wingless females, each of which acts as the foundress of a new colony.

In fighting this Plum Aphis it is important that the spraying should be done early in the spring before the pests have reached large numbers, and before the leaves have curled so as to give

protection against a spray. Theobald[1] recommends as the best spray against the Mealy Plum Aphis, paraffin emulsion or paraffin jelly, with the addition in either case of liver of sulphur at the rate of 1 lb. to the 100 gallons of wash. Theobald's[2] formula for paraffin jelly is

Paraffin	. .	5 gallons.
Soft soap	. .	8 lb.

"Boil the soft soap and the paraffin together, and when boiling add 1 pint of cold water and stir well. This becomes a jelly on cooling; use 10 lb. of this jelly for every 40 gallons of water."

In the case recorded above my correspondent found sparrows feeding greedily on the insect, and in reply to a request for further observation he wrote: "The sparrows persist in coming, so that erect or almost erect branches are bent down by the sparrows sitting on them." At the same time the rose bushes were infested with the Rose Aphis, and a considerable percentage of the best shoots were spoiled by the sparrows sitting on them to eat the Aphis.

The Wheat Bulb Fly (*Hylemyia coarctata*).

The Wheat Bulb Fly continues to be the cause of considerable loss on wheat. In the 'Transactions' for 1912 I gave some notes on this insect and of the damage done to young wheat by its maggots, which feed in the heart of the young plant and cause the death of the shoot. We are still ignorant of the complete year's life of the Wheat Bulb Fly. Attack of the fly is worst after certain crops than others. At the time of the publication of 1912 'Transactions,' Mr Anderson of Balerogie gave me this note of his experience: "A field of strong loam of 14 acres was planted—12 acres with President and King Edward potatoes, and the other 2 with Evergoods, whose shaws went off early. On this last the wheat was very much worse (with Wheat Bulb Fly). I gave the 2 acres a dressing of nitrate of soda, at the rate of 1 cwt. per acre, but one-third of the 2 acres won't be half a crop; the other 12 acres will be a fair crop." Another correspondent, with great experience, writing me from a part of the country where the Wheat Bulb Fly maggots have been very destructive, sends the following notes, based on observation and inquiry: "The ravages of the larvæ show in the month of March, but are more noticeable in the middle of April, towards the end of April, and even the first fortnight of May. We know of several pieces of wheat which still (May 23) show signs

[1] 'Report on Economic Entomology,' September 1907, by Professor F. V. Theobald, M.A., F.E.S.

[2] 'Insect Pests of Fruit,' by F. V. Theobald, 1909, p. 516.

of going off, and which are being ploughed little by little for potatoes and turnips. Crops of wheat after another straw crop appear to be absolutely free from this pest, while crops after turnips and clover appear to be almost untouched. Crops after mid-season, or late potatoes, are attacked to some extent; but by far the worst crops are those which follow a crop of early potatoes lifted in July, followed by a crop of transplanted mangels. With such crops the land is practically worked the whole of the season, as the land is scarified continuously throughout the growth of the potatoes, and also the subsequent mangels. The last-named class of land was usually sown as soon as possible after the lifting of the mangels; whereas in the case of mid-season or late potatoes only a matter of a few weeks would elapse between the potatoes being lifted and the wheat being sown." At the moment, in absence of fuller details as to the biology of the insect, helpful advice is difficult to give, but the problem may ultimately be solved by cultural methods rather than by destructive measures directed against the larvæ. In districts that suffer it would be advisable to arrange if possible that wheat did not follow potatoes.

THE CABBAGE ROOT FLY, *Phorbia (Chortophila) brassicæ.*

Growers of cabbages, cauliflowers, radish, broccoli, and turnip do not need to be told what a scourge the maggots of the above-named fly can be to these crops. The Cabbage Root Fly has proved a most intractable pest in Europe and the United States and Canada, and references to it are abundant in the literature of Economic Entomology. Specially in Canada and the United States there have been experiments on a large scale to test methods of prevention and remedy. Two score and more insectifuges or insecticides have been tried, but none of them with success comparable to what has been obtained in Canada and the United States with Tarred Felt Paper Discs fitted round the newly transplanted cabbages and cauliflowers. The purpose of the discs is to prevent the female flies from laying their eggs so close to the plant that the maggots on hatching can make their way to the roots. In the 'Transactions' for 1904 I gave a short account of this preventive method, pointing out that in the United States one grower had by this means protected 7000 plants, and another 10,000 to 15,000 plants successfully. The protecting disc or collar was first used successfully by Professor Goff[1] in the United States in 1889, and for almost twenty years the method has been practised in Canada. When I visited Canada some years ago, Mr Arthur Gibson of the

[1] 'Eighth Annual Report of the Experimental Station of the University of Wisconsin,' 1891.

Entomological Department of Canada gave me interesting details of his methods, and since then the Entomological Branch of the Department of Agriculture, Canada, has published a very thorough and very complete Bulletin[1] on the subject, in which Bulletin strong evidence is adduced in favour of the discs. In Britain and Ireland no extensive use of these tarred discs has ever been made, and in some cases the method was tried and rejected on the ground of expense. Fresh interest, however, has been awakened in the tar-felt-disc method of prevention by the successful experiments in Cheshire under-

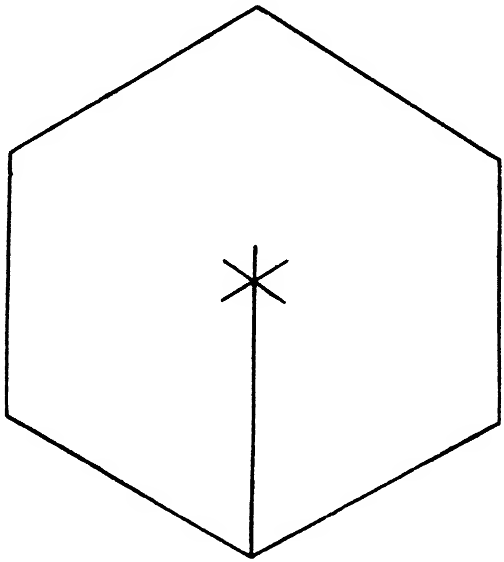

Fig 35.—*Appliance for preventing Maggot attack upon Cabbage*

taken by Mr J. T. Wadsworth, Research Assistant in the Department of Agricultural Entomology, Manchester University. Mr Wadsworth's experiments are fully described in 'The Annals of Applied Biology' for January 1917 (Cambridge University Press). The 'Journal of the Board of Agriculture' for March 1917 contains an appreciation of Mr Wadsworth's work by Dr A. D. Innes, who quoted additional evidence in favour of the discs. The experiments were with cabbages and cauliflowers. Of 816 cabbage plants, 408 were left unprotected, while the other 408 had the paper collars put round them the day after they were planted out. The attack of the maggot

[1] 'The Cabbage Root Maggot and its Control in Canada,' by Arthur Gibson and R. C. Treherne. Ottawa, 1916.

was not so severe on the cabbages as on the cauliflowers; but whereas out of the 408 cabbage plants protected by the discs only one was lost, 54 were severely attacked out of the 408 non-protected, though some recovered. As regards the cauliflowers, 932 plants were experimented with; 466 were left unprotected, the other 466 were protected by the tarred felt discs placed in position on the day of planting; "only 24 cauliflower plants were lost out of the 466 protected by discs, whereas 294 were lost out of the 466 unprotected ones." The discs used in the Canadian experiments were those described in my 1904 Report—viz., six-sided cards, almost three inches across, with a slit reaching to the centre, and with a star-shaped cut in the middle to fit well round and catch any thickness of stem (Fig. 35). "To place the card in position bend it slightly to open the slit, then slip it on to the centre, the stem entering the slit, after which spread the card out flat and press the points formed by the star-shaped cut round the stem."

The discs used by Mr Wadsworth were square, "2½ inches each way, with only two slits, a long slit extending from the middle of one edge to a point half an inch beyond the centre of the disc, and a short slit three-quarters of an inch long crossing the long slit at right angles in the centre of the disc." The discs cost two dollars a thousand, and were procured from A. B. Cowles, 25 S. Water Street, Rochester, New York. The address of a maker of discs in England (1s. per 100, or 8s. per 1000) can be had from the Secretary, Board of Agriculture and Fisheries, Whitehall Place, London, S.W.

As the purpose of the discs is to keep the flies from getting close to the plant for a favourable position for egg laying, the ground must be sufficiently smooth and level to let the cards lie flat on it, and to keep the flies from crawling under the cards. Further, the upper surface of the cards should be kept free from soil.

THE ROSY RUSTIC (*Hydrœcia micacea*).

This is a Noctuid moth, whose caterpillars are general feeders not confining themselves to one species of food plant. As a general rule wild plants are the hosts—*e.g.*, horse-tail (*Equisetum*), sedges (*Cyperus* and *Carex*), dock, valerian, plantain, in all of which the caterpillar tunnels, not feeding externally, but boring under cover. There are records, also, of attack on cultivated plants. I have a record of damage to a Hollyhock; on the Continent it has been recorded as causing great damage to hops, penetrating the young shoots and making long galleries, causing the plants to wilt, and preventing the formation of the fruit. Theobald records the caterpillar as destructive to tomato

fruits[1] and to potatoes.[2] I have two records in my notes of attack on potatoes, one from the middle of England and one from Lancashire. The Lancashire correspondent wrote that he had also been troubled with this caterpillar among his potatoes in Ayrshire. Fig. 36 shows the caterpillar galleries on potato and the consequent wilting. The caterpillar was taken from the wilted shaw. The moth is not an uncommon one, and is

Fig. 36.—*Stem of Potato tunnelled by caterpillar of* Hydrœcia micacea.

Reduced. From nature

found flying in the autumn. The caterpillar is found from June on to the autumn. The colour of the caterpillar is pinkish grey-brown or purplish brown, the under surface being pale; all over the body is a series of black dots or warts, from each of which a bristle springs. The caterpillar has sixteen legs, of the pale colour of the under surface of the body. The pupa is brown, and is found in the soil.

[1] 'Report on Economic Zoology for 1907,' by Professor Theobald.
[2] 'Irish Report on Economic Zoology for the British Museum,' 1903, by Professor Theobald.

Furniture Beetles.

Every one is familiar with the small round holes which can be found in pieces of furniture in houses, and some have heard the strange ticking noise that sometimes comes from furniture or wood. The ticking noise is due to the presence of small beetles, and the holes are the exit-holes by which the beetles bored their way out, after their development in the wood. The ticking noise is really a call note or "love song," and by means of it the two sexes signal and communicate with, and find one another. The beetles have hard horny heads, and these are knocked against the wood. Writing in the 'Entomologist's Monthly Magazine,' London, 1867, Mr F. Smith tells how he kept for a short time some of these small beetles in a box, and that when he tapped the table near the box with a lead-pencil the beetles responded by ticking in return.

One of these furniture beetles is named *Anobium domesticum* (*striatum* Oliv.), a popular common name being the Death Watch, from the superstitions and stories that, on account of the ticking, which is heard most readily at night and by invalids or sleepless people with their nerves on the stretch, have come to be associated with the beetle. *A. domesticum* is not the only Death Watch, for some other species tap and give the ticking sound.

Year after year specimens and queries reach me concerning *A. domesticum*; some of the most recent infested articles have been a picture-frame, a bookcase, an ornamental basket-work fire-screen, an old-fashioned spinning-wheel.

The adult *A. domesticum* beetle measures from $\frac{1}{8}$ to $\frac{1}{6}$ of an inch, and is brown in colour; its head is withdrawn or sunk in the forepart of the body, which suggests a hood when looked at from the side. The wing covers show longitudinal ridges and furrows, and are covered with short hairs. There are six legs easily visible, unless when the beetle feigns death by withdrawing its head and tucking its legs under the body; in this condition of trance or pretended death the beetle may be pretty roughly used without being tempted to show signs of life.

The actual damage is done to the infested wood or piece of furniture by the grub of the beetle. The larva is a soft-bodied grub with horny head and six weak legs; the jaws are fitted for gnawing; the body is wrinkled, hairy (on magnification), and white, except the head, which is brown.

The eggs are laid in crevices or chinks in the wood or piece of furniture, or in wood already attacked, close to the exit-holes or in the tunnel. The grub on hatching eats into the wood, making a tunnel, which is choked up behind the feeding grub

by excrement and boredust. When full grown the grub comes nearer to the outside again and there becomes a pupa. When the pupal stage is over and the beetle is ready, it eats its way through the thin portion of wood that separates it from the open.

The largest of the Death Watches is *Xestobium tesselatum*, which measures from ⅓-in. to slightly over. In correspondence to its greater size it makes a louder ticking than *A. domesticum*. *Xestobium tesselatum* is found at work out of doors as well as inside. When inside, oak is its favourite wood.

Fig. 37.—*Piece of Oak tunnelled by larva of* Xestobium tesselatum.

Natural size From nature.

Fig. 37 shows a piece of oak quite spoiled by the grubs of this beetle, and Fig. 38 shows the exit-holes gnawed by the escaping beetles.

How infested pieces of furniture should be treated depends to a great extent on the bulk of the object, and whether or no the wood is plain or delicate and polished. The best measure would have been a protective one, the timber having been impregnated, before use, with a deterrent or a poison that would have penetrated to a considerable distance. Part of the failure that often attends the painting of the outside of an infested piece of furniture with some insecticide for remedial purposes is that the insecticide does not penetrate sufficiently far to reach the

grubs. Considerable protection is given to furniture just from the very fact that it is polished. Surfaces that are painted over and polished and without cracks are difficult, if not impossible, for the beetles to attack successfully. Rough backs or concealed portions serve as starting-off places for the beetles, and in time the whole piece of furniture succumbs to this flank attack. A large piece of furniture could be fumigated with sulphur dioxide (sulphur fumes bleach and ruin certain fabrics) or hydrocyanic acid gas (a very poisonous gas, therefore such fumigation should only be done by a thoroughly qualified person).

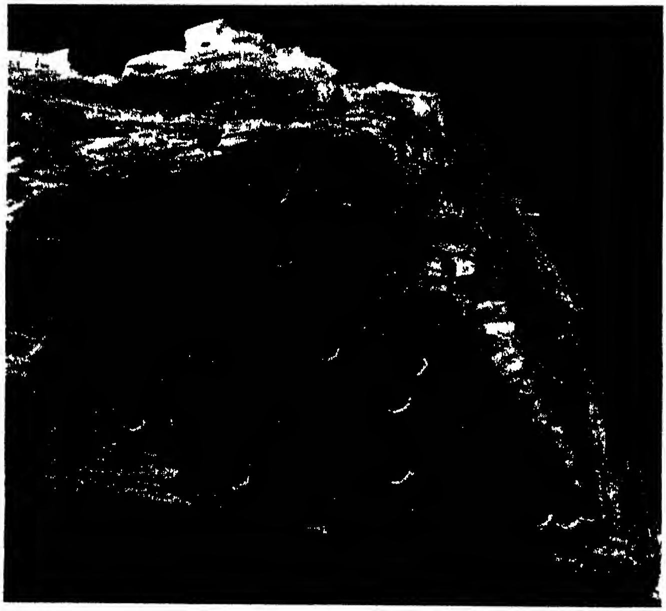

Fig. 38 —*Piece of Oak showing exit holes of* Xestobium tesselatum

Natural size From nature.

Paraffin is useful; the holes (in a small piece of furniture) should be treated individually by means of a syringe with a very fine nozzle. Where the object allows, an excellent measure would be to steep it for some time in a bath of paraffin or in boiling water. If an infested piece of wood could be subjected to a temperature of 125° Fahr., the insects—adults, grubs, and pupæ—would all be killed. In a report made some years ago I suggested the painting over the attacked wood with naphthalene 780 grains, corrosive sublimate (a dangerous poison) 80 grains, methylated spirits 1½ pints; crevices especially should receive treatment.

ANOBIUM PANICEUM (*Sitodrepa panicea*).

This is a smaller Anobiid species, reddish-yellow in colour, with a close covering of hairs, some of which are long. This bettle is destructive to comestibles, flour, biscuits, coffee, beans, drugs of different kinds, spices, and also to leather; books, manuscripts, and pictures are also destroyed by it. Fig. 39 shows a dog-biscuit from which I reared the beetle. Lying on the biscuit there are also the flour beetle (*Tribolium*), the caterpillars of the Mediterranean Flour Moth, and the adult and grubs of the

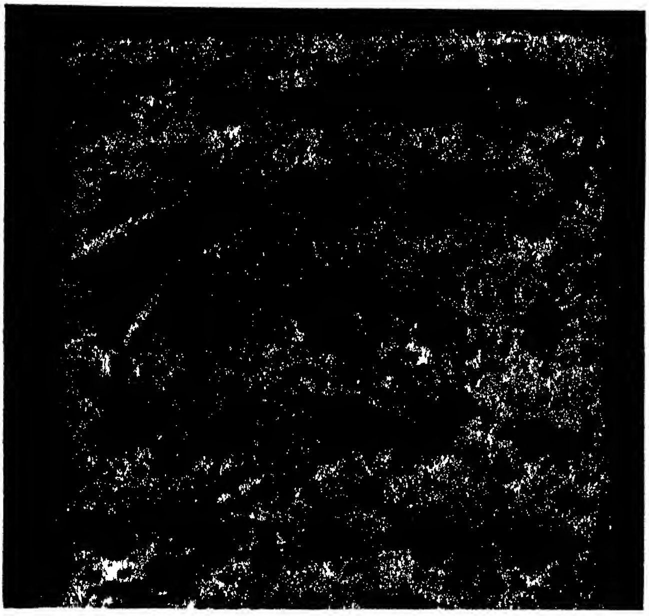

Fig. 39.—*Piece of Dog biscuit infested by* Anobium paniceum. Lying on the biscuit are other insects found among biscuits.

beetle *Trogosites mauritanica.* The last-named beetle was feeding on the others. Fumigation with bisulphide of carbon would be the best treatment in such a case as this.

THE RED OR YELLOW HOUSE ANT (*Monomorium pharaonis*).

This cosmopolitan insect is common in many places in Britain. Recently specimens have been sent to me from Roxburghshire, Edinburgh, and Aberdeenshire, accompanied by complaints concerning their large numbers and the worry and trouble they were causing. One letter stated that, in

spite of every effort to have the nuisance removed, the ants were as troublesome as ever. "We had the fireplace in our property removed, and a nest was discovered there and destroyed; but on the fires being again put on, the ants at once reappeared. All kinds of insecticides have been used without avail. Three and a half cwt. of sulphur have been burned, the doors and windows being all papered up to prevent the fumes escaping. After fumigating on two separate occasions, the fires were again put on to see whether or not the insects were still there, and they have been gradually coming back again." This disheartening letter is not exceptional. I have known these insects for more than twenty years in Edinburgh as invaders in places where comestibles are stored. In one such place where large quantities of fruit and confectionery and cakes are stored, a man is employed whose almost sole work is the destruction of these ants. What makes the insects so difficult to fight is their enormous numbers, great power of multiplication, and the making of their nests and founding their colonies in inaccessible places behind solid masonry and machinery where it is impossible to reach them.

One can get a general idea of the position of nest or colony by following a procession of the workers—the larger males and females can also be seen at certain times—to the food material and back again.

These ants feed greedily on all kinds of sweets, cakes, fruit, and fat, and they are also carnivorous. As regards their love of fat, one stone wall in a storeroom that I know is marked all over with burned areas; in fighting the ants in this place small pieces of fat, lard, rancid butter, were periodically placed here and there over the wall; the house ants swarmed to and over these, and a lit taper applied to the traps destroyed the ants in hundreds.

I have seen these ants trapped in thousands by laying here and there food material of different kinds, but the process is extremely tedious, although it helps to keep down the number of the insects. Temporary stores of comestibles or articles for which protection is desired can be protected against the ants by surrounding the receptacles containing them with water, or, for example, by standing the legs of a table, on which the articles to be protected are placed, in vessels holding water. The only real annihilative measure is the destruction of the nests, and these are often practically impossible to reach without dismantling a great part of the building. It is almost useless labour to do this if the species is present in neighbouring places and these are allowed to remain untreated.

DAIRY BACTERIOLOGY.

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PART I.—BACTERIOLOGY OF MILK.

Introduction.

EVERY one has heard of and knows something of bacteria, germs, or microbes; and every one is more or less familiar with some of the evidences of bacterial life around them, such as the decay or rotting of lifeless organic matter, the wasting or spoiling of anything which does not "keep," or the prevalence and spread of infectious diseases. Every one at the present day knows that such phenomena are in some way connected with germ life. But it was only about seventy years ago that this was first suggested; and for a long time after bacteria were commonly looked upon, and we believe still are by many, as being wholly inimical to human life and prosperity, as something to be avoided, and wherever possible stamped out. It was not till about twenty-five years ago that bacteria were first believed to have any essential part to play in agriculture and dairying.

Agricultural and dairy bacteriology has practically all developed within the last twenty years, most of it within a comparatively few years, and knowledge in this department of science is by no means yet complete. The teachings of the best authorities of the present day differ in many important points.

Bacteriology is the science which deals with the "micro-organisms," or organisms so small that they can be observed only by means of a powerful microscope. It includes not only bacteria, but also yeasts and moulds, all of which play an important part in dairying. Of the various sciences which apply to the dairying industry, bacteriology undoubtedly has the most direct bearing on the subject. Milk and milk products are particularly susceptible to the influences of micro-organisms, and practically all the measures and precautions adopted by the modern dairyman or dairymaid in the handling of sweet milk and cream, or in the making of butter, cheese, or margarine, are based upon the known influence of micro-organisms on these commodities. The whole practice of modern dairying has been established upon bacteriology as a foundation, and

the successful dairyman and dairymaid are practical bacteriologists. As nearly all the changes that take place so readily in milk and milk products are due to the presence and activity of micro-organisms, the importance to the dairyman or dairymaid of some knowledge of the bacteriology of milk is evident. Success in the handling or manufacture of dairy products implies success in controlling or regulating bacterial activity.

Bacteria were first discovered by Leuwenhoek in 1675. By means of a crude microscope of his own construction, he observed tiny moving organisms in putrefying liquids and in saliva. He concluded naturally that these were minute animals, and they continued to be classed as animals until about the middle of the nineteenth century. It was only after improved microscopes had been introduced, and bacteria could be more distinctly observed, that they were proved by Cohn to be more like plants.

The next great advance, perhaps the greatest in the history of bacteriology, was made by Pasteur in 1857. He originated methods of making "pure cultures" of bacteria. Until this could be done, the different species could not be isolated and studied separately, and little could be known of their individual characteristics. From this time onward a great deal was learned of the characters of different species of bacteria, and the effects they produce in different media and under different conditions, and also of the general functions of bacteria. It was found that many species were useful in certain circumstances, though harmful in others; that many species were absolutely essential to the growth and prosperity of plants and animals; and it was realised that bacteriology offered a wide field for study and research.

Dr Lister in 1877 was the first to isolate a milk-souring organism, and Dr Storch of Copenhagen, in 1890, applied the principles of pure-culture fermentation to butter-making. He selected a certain organism on account of its ability to produce a desirable souring or "ripening" in the cream and a good flavour in the butter, and introduced cultures of this germ into pasteurised sweet cream. This system has been widely adopted in all the principal dairying countries, and the result is a marked improvement in the quality, and particularly in the uniformity, of the butter. Practically the same principle has been applied to cheese-making with almost equally good results.

Distribution of Bacteria.

Before proceeding to consider the effects of micro-organisms in dairying, and the methods of controlling and regulating bacterial changes, it is necessary that we should deal briefly

with the nature and structure of bacteria, their natural distribution, and the conditions which favour or retard their growth. Otherwise, in the case of a large proportion of readers, the significance of much that should be included in this article would no doubt be lost.

Bacteria are very widely distributed, probably more so than any other form of life. This is doubtless due in large measure to their very small size and their wide range of conditions for growth and multiplication. They abound almost everywhere around us, in earth, air, and water, and what they lack in size they make up in numbers. There may be hundreds of millions of them in one drop of milk or other fermenting liquid. Indeed, it is easier to say where they are not than where they are likely to be found. There are no bacteria deep down in the earth, the depth varying according to the nature of the subsoil. At depths of over six feet there are in general very few to be found. The earth acts as a filter for bacteria. There are few or no bacteria in spring water, or in deep well water, or in artesian wells. In surface water they are abundant, and particularly in water from cultivated fields and inhabited places.

In the air bacteria are numerous, though they cannot multiply in the atmosphere; they merely exist there. They are specially numerous in the air of cities and towns, in any building containing a number of animals, and in the atmosphere in proximity to fermenting or decaying matter of any kind, especially where such has become dry. There are fewer bacteria in the air over high hills or sparsely inhabited places.

Speaking generally, there are no living bacteria in the healthy tissues of animals or plants. Such contain certain elements capable of combating invasion by germs and destroying the germs which enter. But the digestive and respiratory tracts of all animals teem with bacteria of many different kinds. The intestines of animals are a hotbed of fermentation, and fecal matter is extremely rich in bacteria. Bacteria from this source become disseminated widely into soil, sewage, water, cattle foods; and from these into meat, milk, &c.

Bacteria find means of passing naturally from one habitat to another. They are in large numbers in all cultivated soils. In a sense we may look upon the soil as their headquarters or main sphere of activity. From there they pass in the various fodders and other foodstuffs into the digestive and alimentary tracts of animals, into dung, the air, milk, &c., and back again to the soil in animal excrement. One of the main reasons why farmyard manure is so essential to the maintenance of fertility of soils is on account of the micro-organisms it contains.

It may be that there is no such natural distinction as desirable and undesirable bacteria; all may be useful in their proper place. For example, many different species of indispensable soil bacteria are able to establish themselves and produce injurious fermentations in milk, butter, and cheese; and even bacterial disease may be caused merely by certain bacteria, otherwise useful, getting out of their proper sphere.

Morphology.

Probably the most striking characteristic of bacteria is their extraordinary minuteness. Bacteria are the smallest of all known forms of life. They can be observed only through a powerful microscope, preferably one magnifying by 800 or 1000. One thousand millions of bacteria can often be found in a single drop of fermented milk or other liquid. Bacteria, like other organisms, vary widely in dimensions. Proper or improper nutriment has a marked effect on the size of bacteria of the same species. The average diameter of the bacterial cell is usually given as about the thirty thousandth part of an inch ($\frac{1}{30000}$ inch).

Most organisms are classified according to form or outline. Thus, we know our breeds of horses, cattle, and sheep from each other by external appearance. But in the case of such minute and simple structures as bacteria there is considerable difficulty, as they present comparatively little difference in external form. There are, however, three main types according to which bacteria are roughly classified: (1) spherical or ball-shaped; (2) elongated or rod-shaped; (3) spirally twisted or corkscrew-shaped. The spiral types are fairly common in soil but comparatively rare in milk.

But when studying any particular fermentation it is necessary to know definitely to which particular species the causal germ belongs, and characteristics other than form have to be considered, such as: (1) the manner in which the bacteria grow in cultures in different nutrient media; (2) the effects actually produced in the different media, or the effects produced upon certain animals.

The extreme minuteness of bacteria, and the fact that they are practically colourless, make close study of their structure difficult. The microscope reveals a unicellular or one-celled organism, consisting of a very delicate cell wall containing living matter or "protoplasm." A germ may be described, therefore, as a tiny speck of living matter. Certain species, termed "motile" bacteria, have tiny hair-like structures on the wall of the cell. These are organs of locomotion, and by rapid vibration of these organs the germs are able to propel them-

selves through a liquid medium with a more or less rapid swimming motion.

Most bacteria are individually colourless, but crowded together in large numbers in cultures, they appear to be of a slightly whitish or yellowish tinge. A number of species, however, are remarkable for the brilliant coloration of their cultures: blue, different shades of red, yellow, orange, or violet. Some are brightly fluorescent. In most cases the colouring matter is a secretion or product of the germ.

Biology.

Another characteristic feature of bacteria is their power of rapid multiplication. There are two methods of reproduction among bacteria: (1) by simple division of the cell, or "fission"; (2) by spore formation. The former is the method of increase or multiplication; by the latter method one germ usually produces only one spore and then dies off. The first method is characteristic of bacteria. The mother-cell gradually increases in size as a result of growth, and ultimately divides into two smaller but equal-sized daughter-cells. These in turn grow to full size and divide. Thus, the "old" cell produces two "new" cells. Multiplication by this process means the duplication of the individual.

The rate of multiplication depends upon the conditions of growth, and more particularly upon food supply, moisture supply, and temperature. Under favourable conditions the cholera germ requires only twenty minutes from the time division takes place until the new cell in turn divides; *Bs. subtilis* takes about thirty minutes; more often the time required is about an hour. But even at the latter rate the increase is astounding. One germ may become in twenty-four hours the ancestor of over sixteen millions; and if conditions continued favourable the progeny of one germ in five days could fill the entire ocean. But, fortunately, the external conditions do not remain favourable for long at a time.

The ordinary bacterial cell cannot resist the injurious effects of unfavourable conditions, such as drought, famine, too high a temperature, &c., for any great length of time. Many species, however, are able to cope with unfavourable circumstances by assuming a form possessing great power of endurance termed a "spore." The bacterial spore is still smaller than the ordinary bacterial cell, and has a much thicker cell wall, which gives it stronger resisting power. Sporulation is adopted by spore-forming organisms when the external conditions become unfavourable and threaten to exterminate the species.

Not all bacteria have the power of forming spores. Spores

are still unknown in many of the pathogenic (disease-producing) bacteria, and also in lactic (milk-souring) bacteria. On the other hand, many of the species commonly found in milk form very resistant spores. Sporulation has a direct effect in sterilisation or disinfection, as sporing bacteria are much more difficult to exterminate in any medium. For example, the spores of *Bs. subtilis*, a bitter-producing germ commonly found in numbers in milk, can withstand boiling in water for about three hours and still retain their power of germinating.

Living, ripe spores are capable of germinating and producing new bacterial cells whenever they find themselves under suitable conditions of growth, but they can remain in the resting stage for a very long time, some of them for years, and afterwards germinate.

Like other organisms, bacteria require for their growth and wellbeing certain conditions. The chief of these conditions are—

(1) A supply of suitable food.
(2) Sufficient moisture.
(3) The presence of some form of oxygen.
(4) A favourable temperature.
(5) The absence of inhibiting conditions, such as poisonous substances, strong light, or excess of their own products.

It is chiefly from a knowledge of the conditions governing bacterial growth that we are able to induce particular fermentations or inhibit them in any medium, in the laboratory, or in the dairy.

Owing to the large number of different species, bacteria differ widely in their food requirements, but the majority of the germs of direct interest in dairying require food in the form of organic materials, albuminous and carbonaceous, such as meat, milk, vegetable matter, &c., and are thus dependent for their food upon the growth of higher plants or animals. Those which utilise only lifeless matter are known as "saprophytes"; those which are able to derive their nourishment from living tissues of plants or animals are termed "parasites." The saprophytes comprise by far the larger number of species. Those parasites which cause the various communicable diseases are known as "pathogenic" bacteria. But between the groups there is no very sharp line of division.

Bacteria, like ordinary plant cells, must imbibe their food in solution. The material, dissolved in water, passes through the porous cell wall. Growth is most rapid when the moisture content is 90 to 95 per cent of the medium. Bacteria will hardly grow at all unless there is moisture present to the extent of

about 30 per cent. They are capable of living in or on solid substances, but the food elements must be rendered soluble before they can be taken into the cell. Many species produce and excrete from the cell digestive chemical substances termed "enzymes," which dissolve otherwise insoluble material. Growth is hindered if the nutrient liquid is too concentrated—as, for example, in syrups, jams, condensed milks, salt solutions, &c. Drying acts as a check to bacterial growth, and any foodstuff which can be dried can be preserved—such as dried fish, meats, fruits, milk, grain, fodder, &c. Butter and cheese are partially dried forms of milk.

Drying does not necessarily kill the bacteria. Many may remain in the dry state for weeks, some for months, and a few even for years, and be capable of growing and multiplying as soon as they find sufficient moisture. Naturally, the sporing bacteria withstand drying much more successfully. Germs are readily transported from place to place in the dry state as dust; on the other hand, bacteria do not readily rise from a wet surface.

All living bacteria need oxygen, and bacteria may be divided into two classes with regard to their oxygen requirements. Some species grow best in the presence of air or free oxygen, and are termed "aerobic" bactoria. Some seem not to be able to grow successfully in the presence of air, and grow best when air is absent or when very little air is present; they prefer to take the necessary oxygen from oxygen compounds; these are termed "anaerobic" bacteria. Other species, again, can grow quite successfully either in the presence or absence of air. It is obvious, therefore, that the presence or absence of air in any medium may have a great influence in determining the natures of the fermentations which occur. For example, the conditions for bacterial growth at the centre of a large cheddar cheese, or at the bottom of a deep volume of milk, are very different from those on the surface of a small piece of butter.

Growth of bacteria is very largely controlled by temperature. Growth can occur only within certain temperature limits, and there is for each species a certain temperature which is most favourable. The optimum temperature for any particular species is generally nearer the maximum than the minimum. For many common species the range of temperature from minimum to maximum is from 33° Fahr. to 50° Fahr. to between 107° Fahr. and 112° Fahr., the optimum being from 77° Fahr. to 96° Fahr. Yet some species can grow successfully at comparatively low temperatures, such as a few degrees above freezing point. On the other hand, the bacteria which have adapted themselves to live chiefly in the intestines of animals grow most rapidly at about 104° Fahr.

Cooling to about 40° Fahr. generally prevents bacterial action, and at freezing temperature practically all bacterial growth ceases. Yet exposure to even very low temperatures does not as a rule kill bacteria, but merely produces a lethargic condition.

Exposure to high temperature, on the other hand, destroys bacterial life—even the life of spores. The death point varies with—

(1) The kind of heat: with dry heat a higher temperature is necessary.

(2) The time of exposure: the longer the exposure to an injurious temperature, the lower is the temperature required.

(3) With the species of bacteria: some species are much more resistant than others.

Most growing cells are killed by exposure to a moist heat of 140° Fahr. for ten minutes. The spores of bacteria, however, resist high temperatures for a considerable time; but in general bacterial spores are destroyed by continuous boiling for from one to three hours, by exposure to steam under pressure at 260° Fahr. for twenty minutes, or by a few minutes exposure to a dry heat of 300° Fahr.

Acids or alkalies in the medium are repellent to the majority of bacteria. In general bacteria grow more rapidly in a medium which is practically neutral, or only slightly acid or slightly alkaline. But a few species grow freely in an acid medium—notably the lactic bacteria, the butyric bacteria, the acetic bacteria, and particularly the lacto-bacilli; though even these organisms are checked entirely when the acidity reaches a certain point. Many bacteria secrete an alkaline substance and make the whole medium alkaline.

Bacterial growth is favoured by darkness, or weak daylight; but ordinary sunlight is injurious, and in time is fatal, to bacteria. Direct sunlight soon kills even the spores of bacteria. Sunlight is our most important and most widely acting disinfectant.

The products of bacterial growth, when they accumulate in a medium, act as a deterrent. The first effect to be observed is a general weakness or debility of the organisms. If accumulation of products continues the bacteria gradually lose their fermentative power. For example, milk sours normally until the acidity reaches 0·9 or 1 per cent, at which point development of acidity is entirely suspended. Much of the trouble experienced with dairy "starters" may be traced to the effect of high acidity on the starter organism.

Many chemical substances have an inhibiting, and many a toxical or poisonous effect on bacteria. Those which are strong

enough to kill bacteria and bacterial spores are termed "disinfectants" or "germicides," while those which are weaker in action and merely prevent growth are known as "antiseptics." Some substances which are not poisonous have a retarding effect on bacteria, such as common salt, chloride of potash, sugar, &c. The effect of such substances is chiefly physical; they merely interfere with the feeding processes.

Bacteria produce characteristic products and chemical changes in the medium in which they grow. This phenomenon is termed "fermentation." Fermentation accompanied by production of foul-smelling or putrid gases is termed "putrefaction." The ferment or active principle is a peculiar chemical substance termed an "enzyme," and is produced by the germ. Each different species of bacteria produces its own peculiar effects by means of its own enzyme or enzymes. Thus, the lactic bacteria in milk produce lactic acid, while putrefactive bacteria produce putrid-flavouring substances. Certain of the putrefactive germs also produce "ptomaines" or "toxins," which are dangerous poisons.

All fermentations result in heat being generated. In most instances the heat produced is not great, but under certain conditions some organisms liberate a large amount of heat, and a considerable increase of temperature takes place,—for example, in dung-heaps and in damp grain or hay.

Milk as a Medium for Bacteria.

In many respects milk is a highly suitable medium for many species of bacteria and other micro-organisms, and therefore sweet milk is a very perishable commodity. Let us consider in this connection the different constituents of milk in detail. Only a very few species are able to ferment the milk fat; the fat is the best-keeping part of milk. Milk caseine can be utilised only by a protein digesting or "liquefying" species. The albumen in milk is already in solution, and is a readily available form of protein food for almost all species of bacteria, and the presence of albumen in milk has a most important effect in promoting fermentations. Sugar in milk is also in solution, and is admirably adapted for bacterial energy. The milk salts are eminently suited to the needs of practically all kinds of micro-organisms. Free oxygen or air is present in milk as a rule only in small quantity; but the amount near the surface is sufficient for the needs of aerobic bacteria, while anaerobic bacteria are able to flourish deeper down in the milk. The chemical reaction of fresh milk being very faintly acid is very suitable for most bacteria, but it is particularly favourable to the lactic species. All the nutritive substances in milk are

diluted with a proportion of water suitable for bacterial growth. The temperature of newly-drawn milk is also conducive to the rapid growth of germs. Thus, freshly-drawn milk would appear to be in many respects an almost ideal medium for micro-organisms.

The only serious drawback from the bacterial point of view is the bactericidal property inherent in milk newly drawn from the healthy udder. Practically no increase takes place in the number of bacteria, even at suitable temperatures, for several hours after it is drawn—for from six to nine hours on the average—but the period varies with the individual cow and with other conditions. If the milk is cooled immediately to about 54° Fahr. or lower, the period during which no increase in bacteria takes place may extend to thirty or forty hours. But as soon as the germicidal property is lost rapid multiplication occurs.

This bactericidal property has been found to be due to the presence, in all normal healthful milk, of living "leucocytes" or white corpuscles from the blood of the cow. The leucocytes are passed into the milk in large numbers, and retain their vitality for the time stated. Their function in milk is the same as in blood—namely, to attack and destroy germs gaining access, and to serve as a natural provision for the maintenance of the purity of the milk for a given time. In milk from a diseased udder more than the normal number of leucocytes are to be found. But in this case the leucocytes have mostly already lost their germicidal powers in vain attacks on the germs in the udder. After the bactericidal phase, growth of the different species present is not uniform. Certain species find the conditions more suitable and develop more vigorously. This is normally the case with the lactic bacteria producing lactic acid. By increasing the acidity of the milk they gain a further advantage, until ultimately they approximate to over 95 per cent of the total bacteria present. Before this stage is reached the milk is sour and "loppered" or curdled.

It should be clearly understood that lactic fermentation in milk is by no means inimical to health, but beneficial; while practically all other bacterial fermentations, including putrefactive changes, are distinctly injurious. The souring of milk is not the first step in its decomposition, as is commonly supposed, but has the opposite effect of postponing decomposition. In ordinarily clean, healthful milk, in addition to the leucocyte, the lactic germ acts as a natural hygienic agent and makes its influence felt when most required—that is, after the vitality of the leucocyte has diminished. It not infrequently happens, however, in the case of dirty, insanitary milk, that other than lactic bacteria gain the ascendancy and set up injurious fermen-

tations in the milk, giving to it undesirable qualities and producing one or other of the various "milk faults."

Bacteria commonly found in Milk.

In the space at our disposal under this heading we can only describe briefly a few of the more common species of bacteria in each of the principal groups, indicating the main characteristics of each, the effects produced, and the usual sources of infection. The more important species of bacteria found in milk are comprised in the following four groups:—

(1) Putrefactive Bacteria.
(2) Lactic Bacteria.
(3) Butyric Bacteria.
(4) Pathogenic or Disease-producing Bacteria.

Putrefactive Bacteria.

A large number of different species of bacteria produce putrefactive fermentations in dead bodies of plants and animals, and in other organic substances, and break down the compounds of which these are composed into simpler substances, some of which have a putrid or most offensive odour. Putrefactive bacteria are of great value in agriculture. The constituents of manurial ingredients in soils are split up by these organisms, and rendered available for the use of growing plants. Though useful in soil, these germs are very undesirable in milk and milk products, and are responsible for most of the defects in dairy produce of inferior quality.

Though a large number of different species of putrefactive bacteria can be isolated, most of the ordinary putrefactive changes are due to a relatively small number of species. The chief of these are—

1. *Bacterium vulgare* (*Proteus vulgaris*).

This germ is usually to be found in considerable numbers in samples of ordinary milk. It is a common inhabitant of the intestines of man and of animals, and abounds also on putrid flesh and in water contaminated with decomposing organic matter, and it is widely distributed in the atmosphere. It is very variable in form, but is usually a slender, rod-shaped germ, actively motile, non-sporing, and aerobic. It grows most rapidly at about 60° Fahr., or ordinary air temperature. It assists in putrefaction generally. Milk is first rendered alkaline, then coagulated very slowly, and the curd is subsequently dissolved. It has the property of liquefying proteins, such as milk caseine,

with the production of a disagreeable or bitter flavour and odour.

2. *Bacterium coli.*

This germ is also a common inhabitant of the intestines of animals, birds, and fishes, and is present in large numbers in excreta, sewage, and contaminated well or river water, and on decaying flesh; it is also widely scattered in the atmosphere. It is one of the most widely distributed of all germs. It is present in practically all samples of ordinary milk in smaller or larger numbers, according to the degree of contamination. It is a common cause of faulty flavour and gasiness in milk, cream, butter, curd, and cheese.

It is a short, stumpy germ, motile when young, non-sporing, aerobic, and grows best at blood temperature (104° Fahr.); unlike Bacterium vulgare, it does not liquefy or dissolve protein. Milk is first rendered acid and in time coagulated, the curd containing much gas.

3. *Bacterium lactis aerogenes.*

This germ is usually associated with Bacterium coli in the alimentary tract of animals. It is found throughout the intestinal tract and in the stomach, while Bacterium coli is confined chiefly to the large intestines. The germ is very widely distributed, being disseminated chiefly from animal excrements. It is commonly found in impure water and in milk and milk products. Like Bacterium coli, it frequently produces gas and objectionable flavours in milk, cream, curd, and cheese.

This germ is very similar in many respects to Bacterium coli, but it is never motile, and it produces more acid in milk, and coagulates the milk sooner than the latter, while the gas bubbles produced are smaller and more numerous. It is also a blood-temperature germ.

4. *Bacterium cloacæ.*

This is another germ of the coli type, common in the intestinal tract and in sewage, contaminated water, and dirty milk. In its general characters and its relation to dairying it closely resembles Bacterium coli, but unlike the latter, it slowly liquefies curd and other proteins.

5. *Bacterium fluorescens liquefaciens.*

This is one of the most common of all germs in soil, sewage, contaminated water, air, &c., and it is ordinarily present also in milk and other foodstuffs, and assists in putrefaction generally. It is a rod-shaped germ of ordinary size, motile, non-

sporing, and markedly aerobic. It grows well at ordinary air-temperatures (about 60° Fahr.). It rapidly liquefies curd and other proteins, and produces putrefactive changes, usually accompanied by fluorescence. Milk is gradually changed until it turns to a yellowish-green alkaline liquid, with a disagreeable flavour and odour.

6. *Bacterium pyocaneum.*

This germ is a pathogenic modification of Bacterium fluorescens liquefaciens. It is a pus-producing organism commonly associated with septic sores or wounds which do not heal satisfactorily. It is frequently present in considerable numbers in milk from weeded udders.

7. *Bacterium fluorescens non-liquefaciens.*

This germ may be readily isolated from all putrefying substances, and from all samples of ordinary market milk. It resembles Bacterium fluorescens liquefaciens in its characters and in its effects upon milk, but it liquefies caseine only very slightly.

8. *Bacillus prodigiosus.*

This germ is a common inhabitant of putrefying flesh, and is widely distributed in air and water, and in milk and other foods. It sometimes develops red, blood-like spots on food-stuffs such as stale bread, potatoes, milk, &c. It is a rod-shaped germ in liquid media, but is usually spherical on solid media. It is sometimes motile; it is aerobic, and has the power of liquefying proteins. It differs from all the germs already described in that it forms resistant spores. It may produce red spots on the surface of milk allowed to remain at rest, and in time it slowly coagulates the milk and dissolves the curd, with the production of a yellowish colour and a disagreeable flavour. It frequently produces reddish coloration and disagreeable flavours in butter and cheese.

9. *Micrococcus pyogenes* (*Staphylococcus pyogenes aureus*).

This is also a putrefactive germ, and it is of special importance as a cause of several inflammatory or suppurative diseases in man and animals. It is one of the germs associated with garget or "weed" in cows' udders, and it is usually present in dangerous numbers in milk from cows suffering from this disease. The germ is of ordinary size, spherical, non-motile, and non-sporing. It is able to thrive either with or without air, and at either ordinary air-temperature or blood-temperature. It acidifies milk and liquefies caseine, imparting a yellowish colour and a disagreeable flavour to the liquid.

10. *Streptococcus pyogenes.*

This germ is also a cause of inflammation and pus-formation, and abounds in milk from weeded udders. The germs are spherical, and appear in characteristic long chains, the presence of which in milk is a strong indication of contamination from weeded udders. Milk containing large numbers of this germ, as of M. pyogenes and Bact. pyocaneum, must be considered as distinctly dangerous. Such milk may cause inflammatory troubles in the throat, stomach, or bowels. In most respects the germ is similar to M. pyogenes, but it grows only slowly at air-temperature, is non-liquefying, and it acidifies and coagulates milk much more rapidly than M. pyogenes.

11. *Bacillus subtilis* (Hay Bacillus.)

This is more particularly a germ of the soil. It is common in all decaying, organic matter, in soil, air, and in practically all samples of milk and other dairy products. It is present in relatively large numbers in hay and fodders generally. It is a rather large, stout, red-shaped germ with rounded ends; motile, and markedly aerobic. It grows best at air or soil temperature. It is noteworthy on account of its very resistant spores, and for its strong liquefying powers.

Bs. subtilis and other germs resembling it cause a great deal of trouble in milk and in the making of butter and cheese. They secrete strongly alkaline substances which interfere with normal lactic acid development, and liquefy the caseine, producing bitter flavours. Pasteurising the milk destroys the bacterial cells, but not the spores of this type.

12. *Bacillus mesentericus vulgatus* (Potato Bacillus).

This is also a common soil germ, and is generally found in relatively large numbers on potatoes. It is widely scattered in the atmosphere, and is usually present in milk. It is a shorter and smaller germ than the Hay Bacillus, but is similar to the latter in many respects. It also produces very resistant spores. It has practically the same effects upon milk and its products as Bs. subtilis.

13. *Bacillus putrificus.*

The putrefying organisms already described are more or less aerobic germs, but the most foul-smelling substances are produced by anaerobic putrefactive bacteria. The chief of these is Bacillus putrificus. It is found in large numbers in fermenting

dung-heaps, and in considerable numbers in sewage and in the soil, and is usually present also in milk and other dairy products. It is a long, rod-shaped germ, motile, and anaerobic, and forms very resistant spores which arise near one end of the cell, causing the whole cell to assume a characteristic drumstick shape. Milk under anaerobic conditions is changed into a very foul-smelling liquid from which offensive gases are liberated.

Lactic Acid Bacteria.

The fermentative changes which normally occur in samples of ordinary milk have already been described. Speaking generally, it may be said that there is for a time a close struggle for supremacy between the putrefactive bacteria and the lactic bacteria, with the result generally in favour of the lactic bacteria, owing to the pull the latter have in their favour in being able to produce lactic acid which is injurious to most of the putrefactive group.

In lactic acid fermentation it is chiefly the milk sugar which undergoes conversion, the chief product being lactic acid, although other products are formed in small quantity. Acidity begins to be evident to the taste when about 0·3 per cent of lactic acid is present; curdling appears when about 0·6 per cent has been reached, and the curd becomes more solid with increasing acidity. In pure lactic fermentation the curd formed is not liquefied. Generally growth of the bacteria and production of lactic acid cease at about 0·9 per cent or 1 per cent acidity, but the maximum amount of acid developed varies considerably with different lactic organisms. Acid production proceeds unchecked where the acidity is neutralised by calcium carbonate. Cream does not develop so much acidity as milk, as a larger proportion of the volume is fat, and acidity is in the serum. For the same reason rich cream develops less acidity than poor cream.

Over a hundred so-called species of lactic acid producing bacteria have been described; but many of these are closely related forms of the same organism, and the number of distinct species is small. Most of the forms in milk are either spherical or very short rods, and all are non-motile, non-sporing, and non-liquefying. Some grow well in air, but the majority are facultative anaerobes—that is, they are able to grow in air, but grow most rapidly where air is almost entirely excluded. The following four groups are recognised: (1) Streptococcus lactis; (2) Bacterium acidi lactici; (3) Bacterium Caucasicum; (4) Micrococcus lactici acidi.

GROUP 1.

Streptococcus lacticus.

This is the typical bacterium of the group, and the most common of all lactic organisms. It is a widely distributed germ, and most of the souring of milk is due to it. It is the same organism as Bacterium lactis, Bacterium Guntheri, Bacterium lactis acidi, and Lactococcus lactis. It is of a slightly oval form, and occurs mostly in pairs or short chains of four or five cells. It is non-motile, non-sporing, and practically anaerobic. It grows more rapidly below the surface, and at temperatures from 85° to 95° Fahr. In milk it produces acidity and curdling in six or eight hours, the curd being dense and uniform, without gas, liquefaction, or separation of whey. The acid milk has a pure, agreeable flavour and occasionally a fine aroma. Strains of Streptococcus lacticus are the most useful of all lactic bacteria for dairying purposes, and the majority of starters are more or less pure cultures of this organism.

The Streptococcus lacticus species is at first in the minority in milk; it is outnumbered by the putrefactive bacteria. The germs are capable, however, of rapid growth in milk, and by producing lactic acid they tend to keep the putrefactive organisms in check.

Many investigations have been made with a view to finding out the chief source of the organisms—whether it is the leaves of plants, fodder, the soil, the cow, dairy utensils, or the interior of the udder. Lately it has been found that the mouth of the cow is their principal habitat. Inoculations from this source give the thickest growths in cultures. The stalls and any surfaces within reach of the cows' mouths become well stocked with these organisms, and the germs are always present where milking is carried on, and find their way into the milk in greater or smaller numbers.

The germs isolated from fresh milk generally produce lactic acid feebly at first, but their acid-producing power is increased when they are cultivated in milk for some time.

GROUP 2.

Bacterium acidi lactici.

The typical germ of this group is also widely distributed in milk, but rarely in any abundance. Its development would seem to be checked by that of the Streptococcus lacticus type. It differs from the latter in that it grows on or near the surface aerobically, and cannot ferment milk without producing a

considerable amount of gas and a disagreeable flavour and odour. Many of the troubles in dairying are traceable to organisms of this type.

GROUP 3.

Bacterium Caucasicum.

The organisms in this group are in the shape of comparatively large, long rods. They grow more as anaerobes, and produce in milk a much higher degree of acidity than the ordinary lactic organisms, and require a much higher temperature for growth. Probably all the "lactobacilli" should be included in this group.

Bs. Bulgaricus (or Bs. Caucasicus) may be taken as the typical organism of the group. It is one of the active agents of "kephir grains." An increased interest has attached to this germ within the last few years since Metchnikoff recommended fermented milk of this nature as a common article of diet. This germ or allied forms has been found to be the chief active principle in such fermented milks as kephir, yoghurt, leben, mazun, gioddu, and kumiss. The organism can maintain itself under conditions present in the human intestines, and is believed to have a beneficial influence there in controlling injurious fermentations, just as the more common Streptococcus lacticus has in milk. The organism is now supplied commercially in different forms, as in milk, tablets, sweets, and prepared cheeses.

The germ is much larger and longer than the ordinary milk-souring germ. It occurs either singly or in chains. It grows in milk very slowly at ordinary temperatures, but vigorously at 100° Fahr. to 104° Fahr. It is capable of producing a much higher degree of acidity than the ordinary lactic bacteria, in some cases as high as 3 per cent. In other respects it resembles the ordinary lactic species.

The germs were formerly believed to be confined to the fermented milks of Eastern countries, but this was owing to the difficulty of isolating them. It has been found that they are widely distributed in this country in animal excrements, cattle foods, saliva, milk, butter, cheese, and soil, and that they are present in limited numbers in practically all samples of ordinary milk. The chief source of these germs is the intestines of animals consuming milk.

Milk is rendered acid and coagulated in from eight to eighteen hours at 104° Fahr., and a high degree of acidity may be reached. The curd is firm and close, without gas or liquefaction. The germs are used in starters in the making of Swiss Emmental

cheese, and they have also been used in Cheddar cheese-making with good results. Their ability to check putrefactive germs makes them specially useful as a starter. This starter must be cultivated at about 104° Fahr., otherwise it soon deteriorates into ordinary sour milk.

GROUP 4.

Micrococcus lactis acidi.

This group is of less practical importance. The typical organism is a small spherical germ occurring singly or in pairs, never in chains. It grows slowly in milk, but can grow at comparatively low temperatures, and produces bitterness in milk, cream, butter, or cheese. It is often a cause of trouble in refrigerated milk which has to be stored for some time.

Butyric Acid Fermentation.

Butyric acid is readily recognised by its rancid-butter flavour and odour. It is frequently found in old sour milk or cream, inferior butter, and in inferior old cheese. Rancidity in butter, however, is not due to the presence of butyric ferments alone, but to a series of complex changes. Butyric acid fermentation often follows lactic acid fermentation in dairy products for several reasons: (1) the butyric bacteria are anaerobic, and the lactic bacteria remove all air from the milk; (2) the butyric bacteria thrive in a strongly acid medium; (3) the lactic acid is useful to the butyric bacteria, which convert it into butyric acid.

The butyric germs are mostly comparatively large anaerobic bacteria, which form resistant spores. The spore appears in the middle of the red-shaped cell, and ultimately bulges out the cell into the shape of a spindle. There are two main types:—

1. *Motile Non-Liquefying Granulobacillus Saccharobutyricus.*

This is a motile germ. It grows best under strict anaerobic conditions at 95° Fahr. In milk, butyric acid is produced from the milk sugar, and curd full of gas bubbles is formed, but the curd is not liquefied. The germ is widely distributed in water, soils, and cattle foods, and is usually present in limited numbers in fresh milk. Milk kept for some time in an acid condition may contain large numbers of this germ.

2. *Non-Motile Granulobacillus Saccharobutyricus.*

This species is more common in milk, and is also found in water, soils, and in cattle food. It is similar in most respects to the former type, but is non-motile and has the power of liquefying proteins. There are two varieties: (1) a long cylindrical form with rounded ends, often in chains of from three to six cells; (2) a smaller and shorter form, rarely in chains.

Butyric acid fermentation proper in milk is a conversion of lactic acid to butyric acid by the two last-mentioned species, or similar types of organisms, growing under anaerobic conditions. But butyric acid is also produced from the proteins of milk in aerobic fermentations by several species of putrefactive bacteria.

Pathogenic Bacteria in Milk.

It has frequently been proved with regard to a number of infectious diseases of man that milk may be the means of spreading the germs of the diseases. Several of the pathogenic germs, unfortunately, are able to maintain themselves in milk, and some are able even to multiply rapidly in it. The latter naturally are much the more dangerous. For our purpose we may arrange pathogenic bacteria into two classes: (1) affecting man and animals; (2) causing diseases in man only. The former class includes the germs of tuberculosis, foot-and-mouth disease, anthrax, garget (or weed in the udder or inflammation), enteritis. The latter includes the germs of scarlet fever, diphtheria, typhoid or enteric fever. There is no space in the present article for more than general remarks on the organisms causing the more prevalent of these diseases, and the observations are made more from the dairying point of view than from that of the pathologist.

Tuberculosis.

The prevalence of this disease among dairy cows is certainly high and worthy of serious consideration, but we do not hold the alarmist views of some of our medical pathologists. Different authorities give different figures, but it is generally believed that at least from 30 per cent to 50 per cent of our dairy cows react to the "tuberculin test," and are therefore in some degree affected. The disease is spread in the excretions and discharges of affected animals. The germs are coughed up from the lungs, and get into the surrounding atmosphere as dust, or they are passed into the fæces, urine, or milk. The disease spreads much more rapidly in dark, badly-ventilated,

hot, dirty byres, and where there is overcrowding of the animals. Feeding calves on infected milk is another method of spreading the disease.

It is generally admitted that the same species of germ is the cause of the disease in animals and man, though the variety may be different. The germ from the bovine source is thicker, shorter, and less curved than that from the human. It would appear that the bacillus from the human source can make little headway in the animal, but that the disease is more communicable from the animal to man.

The disease may attack any organ of the body, even the bones, but more commonly it is the lungs which are affected, and there is a gradual or rapid wasting away. The causal germ, Bs. tuberculosis, is of variable form, usually rod-shaped, sometimes curved, non-motile, and fortunately non-sporing. It grows most rapidly at a temperature of 104° Fahr., and is killed by exposure to moist heat of 140° Fahr. for twenty minutes. Direct sunlight kills it in a comparatively short time; diffused daylight more slowly. It is destroyed in a 5 per cent solution of carbolic acid in from half to one minute, and in $\frac{1}{1000}$ mercuric chloride in ten minutes. Fortunately, Bs. tuberculosis grows very slowly, or not at all, in milk. A suitable medium for its cultivation is flesh bouillon containing 5 per cent to 6 per cent glycerine. Comparatively highly-infected milk is undoubtedly dangerous for invalids and young children. Where the disease is observable in the udder the milk is invariably appreciably infected; in the earlier stages of the disease, when it can be detected only by the tuberculin test, the milk is generally unaffected. But between these extremes there is nothing definite. Tubercules may exist in the udder for a long time unnoticed, or the milk may pass from the non-infected to the infected stage unobserved. It may be taken for granted that the milk is unsafe in the untreated state where tubercules exist in the udder, or where the cow is far gone from the disease in the lungs and is visibly pining or wasting. In the latter case, though the milk may be sound when secreted in the udder, it is more than likely to be infected before it leaves the cow.

On the other hand, a "reacting" cow may never suffer at all in health from the disease, and may continue to give healthful milk and plenty of it until she falls a victim to old age. There is good reason to believe that the cow of healthy appearance and apparently sound constitution which reacts slightly to the tuberculin test may be a more natural sort of cow, and a more profitable cow for practical dairying purposes, than one which is entirely free from tubercules. The conditions under which the animals are housed, and the general treatment of the herd,

have probably far more to do with the progress of the disease in a herd than the degree of infection.

With regard to preventive measures, the tuberculin test may be applied to the whole herd of cows, and the reacting animals isolated from the non-reacting, housed in separate byres, and grazed on different pastures. The worst of the affected cows might be slaughtered as soon as practicable. The disease is not strictly hereditary; only a predisposition to it is hereditary. Therefore calves may be kept from healthy reacting cows if they are isolated from the dams and reared on non-infected milk. But it is most important to see that all byres are well lighted, thoroughly well ventilated, and regularly cleaned and disinfected. After all, sunlight, fresh air, liberal feeding, and cleanliness are the best antidotes to tuberculosis.

The danger from infected milk is not so great as is commonly supposed. The disease is transmitted to persons consuming the milk only where the germs are present in very large numbers; even badly-infected milk from a tuberculous udder is innocuous when diluted with forty or more times its volume of sound milk. The germs are markedly parasitic, and, as already indicated, they are hardly able to grow at all in milk, even when the milk is kept at blood heat, which it rarely is. In the case of butter and cheese, the mixing of the milk dilutes the germs, and the treatment during manufacture tends to diminish the number. But all milk suspected of being appreciably infected with Bs. tuberculosis should be pasteurised at not less than 165 Fahr., whether to be sold as sweet milk or used in the making of butter or cheese.

Mammitis, Garget or "Weed" in Udder.

This is an inflammatory or catarrhal disease affecting a quarter or quarters of the udder. The germs attack the mucous membrane lining the ducts of the udder, and there is a shedding of the cells of the membrane and of large numbers of leucocytes. The function of the leucocytes is to attack the microbes, but in this case they are not able to destroy them all, and they themselves are cast out in large numbers along with the germs in the secretion from the affected quarter.

The causal germs are of the Streptococcus pyogenes and the Micrococcus pyogenes types, and are practically indistinguishable from the germs of such diseases as septicæmia or erysipelas in man, strangles in horses, and ordinary abscesses in man and animals. Infected milk may be readily detected in the laboratory by simple microscopic and cultural tests. There are three forms of the disease in cattle—acute, sub-acute, and

chronic. In the former, the first symptoms are a diminution of the milk yield, acidity in the milk, and a tendency for the milk to become rapidly coagulated. There is usually also a swelling of the lining of the teat duct and of the floor of the quarter, and there may be also a swelling or hardness of the affected quarter. The general health of the animal is seldom much affected unless there are other complications. In the early stage the milk contains none of the germs, but it gradually becomes viscous, thick, and yellowish, and more of the nature of pus; later it assumes a dirty brownish tint. Under the microscope the deposit from the milk is seen to consist of masses of pus cells and leucocytes mixed with micrococci and chains of streptococci. Gradually the secretion from the affected quarter diminishes to a small quantity of dirty purulent matter, and the quarter is rendered for the time being useless.

The sub-acute form is more troublesome than the acute, as it is more difficult to detect. The milk is so slightly altered in appearance that it may escape detection till too late, and the trouble may result in a "blind" quarter in the following season. The effects are confined mainly to the teat and the floor of the quarter. The only alteration observed is a thickening of the lining of the teat duct and a cordy feeling in the teat. The first-drawn milk, however, is generally yellowish, curdy, and purulent, and is sufficient to contaminate the hands of the milker and the whole of the milk.

The chronic form usually follows the latter. In this case there may be only one or two hard nodules or "peas" in the teat. The cow may have milked quite well last season, and have calved with a "blind" quarter. The regular milking kept the teat duct open, but during the dry period granular tissue has formed. These nodules or "peas" are suppurating centres which constantly discharge large numbers of the germs and spread disease.

The disease does not receive the attention it deserves. It is widespread in dairy herds, and is distinctly infectious. It causes great loss to dairy farmers. The disease not only decreases the productiveness and value of the cow, but renders the milk obtained of less value. The infected milk is prejudicial to health, and is particularly unsuitable for cheesemaking until it has been pasteurised. Greater efforts should be made to identify the affected cows. Suspected udders and teats should be carefully examined, and in particular close attention should be given to the very first-drawn milk of each teat. A simple bacteriological examination serves to identify the affected samples. The milk of affected cows should be collected separately and scalded to 160° Fahr. before being mixed with the sound milk.

Affected cows should be isolated wherever possible, and milked by a different person, and the hands of the milker should be thoroughly washed in running water before milking each cow. Great care should be taken to prevent infected milk getting on to the beds where unaffected cows are lying. Bacteriological treatment of affected udders is hardly practicable, but syringing the interior of the quarter with 5 oz. of 4 per cent boracic acid solution is recommended.

Typhoid or Enteric Fever.

As far as the milk supply is concerned this is the most dangerous of the infectious diseases affecting the human subject. Infected milk has been proved in many cases to have been the means of spreading the disease. In a number of instances an outbreak of enteric fever has been traced along the route of one milk-cart. The causal germ, Bs. typhosus, can thrive and multiply in milk, so that a slight initial infection of the milk may render it dangerous. This germ closely resembles Bacterium coli. It is checked considerably by the growth of lactic bacteria, and is killed by about 0·5 per cent lactic acidity. It grows more vigorously in milk which has been pasteurised or sterilised, and every care should be observed in dealing with such milk to keep it free from infection.

Infection of the milk by Bs. typhosus in many instances arises from insanitary drains or water contaminated from sewers. Infection may also be caused by some one acting in the dual capacity of dairy attendant and nurse to an infected person. In several cases reported it was found that a dairyman or dairymaid who had apparently completely recovered from the disease continued to discharge the germs.

Control of Bacterial Growth in Milk.

Milk when secreted in a healthy udder is perfectly free from bacteria. It is possible even to extract milk from the udder under completely sterile conditions, so that it will be germ-free and keep perfectly fresh for an indefinite period. But this very rarely can be accomplished. In ordinary practice by the time the milk is removed from the byre it contains large numbers of bacteria.

While the purity or cleanliness of milk may be more correctly judged by a determination of the different species of bacteria in it, and the relative number of each species, the total number present per cubic centimetre is a good indication of its freshness or keeping quality. Milk newly drawn from the healthy udder under ordinarily good conditions of clean-

liness should not contain more than 1000 bacteria per c.c. The following bacterial standards might be adopted:—

Newly-drawn milk . .	not more than 1000 per c.c.
Good sweet milk . .	" " " 15,000 " "
Fairly good milk . .	" " " 50,000 " "
Unsatisfactory milk . .	from 50,000 to 100,000 per c.c.
Very bad milk . . .	over 100,000 per c.c.

There are two distinct methods of controlling bacterial growth in milk: (1) by taking precautions to keep the milk as free as possible from bacteria; (2) by treating the milk so as to retard the growth of bacteria already present. The main sources of bacterial contamination of milk are (1) the utensils; (2) the cow; (3) the atmospheric surroundings; (4) the milker.

Utensils here include those used during milking and afterwards. Only the most suitable utensils should be used for milk. The best are made of pressed steel well tinned, and as far as possible made of one piece of steel, or jointless. Unsuitable utensils would include wooden vessels, rusty utensils of all kinds, badly jointed ware, or copper utensils not properly tinned. Utensils should be constructed for easy cleaning. In cases of rusty utensils or exposed copper the milk dissolves an appreciable quantity of iron or copper, and the solution of iron or copper in the milk has a decided effect in retarding lactic acid bacteria, and at the same time encouraging putrefactive germs. The result is that the milk does not readily sour, but all too soon develops an unpleasant flavour objectionable to consumers.

All utensils must of course be thoroughly cleaned and immersed in boiling water before being brought into contact with milk. Thorough scalding is more necessary for the keeping of the milk than thorough scouring. From the bacteriological point of view visible lifeless dirt is preferable to invisible living dirt. Milk should never be allowed to dry upon the utensils. The latter should be rinsed in cold water until all milkiness disappears, then washed thoroughly in lukewarm water containing a *very little* soda. Strong alkalies should not be used, as alkalinity favours putrefactive fermentations. Finally, they should be immersed in boiling water until they are heated to the temperature of the water. Boiling water kills all life, except in the spores, and also injures the spores to the extent that they are less likely to germinate. Cloth strainers and dippers are a common source of danger, as these are very apt to be overlooked and used indiscriminately.

Bacteria readily find their way into the teats and lower portions of the udder. In some cases various species are to be found well up in the secreting glands, though lactic germs

do not grow there, and, if introduced, soon disappear. Nearly all the germs present in the udder are of a more objectionable type. A good practice in milking is to observe and reject in all cases the first-drawn milk from each teat. The rejection of the fore-milk has the effect of appreciably diminishing the number of harmful bacteria in the mixed milk of the herd, and the habit of taking special note of the first milk affords the milkers a much better opportunity of detecting abnormal conditions in the udders.

The milk of certain individual cows may continue for years to have an abnormally high germ content (over 100,000 per c.c.). In such cases the germs are mostly of the inflammatory or pus-forming type. There would seem to be on the average not less than 8 per cent of dairy cows affected in this way, and these cows add appreciably to the number of germs per c.c. in the mixed milk. Efforts should be made to identify these cows and weed them out of the herd. Where this precaution is taken the keeping properties and the hygienic value of the milk are immeasurably improved.

But under ordinary circumstances most of the bacterial contamination of milk takes place in the byres during milking, and much of it comes from the exterior of the cow and the dust in the air of the byre. Fæcal matter, in which many types of putrefactive bacteria abound, gets on to the coat of the cow and soon dries there from the heat of the body. Then it readily falls in particles directly into the milk-pail, or is carried as dust into the surrounding atmosphere of the byre. All cows in milk should be kept as clean as possible, and before each milking all udders should be carefully cleaned by wiping with a clean, damp, or wet cloth. Dry-brushing is worse than useless.

The bacterial contents of the air of byres is most variable, and the bacterial condition of the milk is greatly aggravated by insanitary byres. Byres should be constructed with a view to the health of the cows and to the production of clean milk. In particular, they should be thoroughly well lighted and ventilated, and have floors which are impervious to moisture and free from all unnecessary crevices. Covered drains and dark corners inside the byre, harbouring dirt and breeding germs, must be avoided. Cleaning should be done regularly, and no fermenting food should be allowed to lie about undiscovered. Every operation tending to stir up dust in a byre—such as feeding or sweeping—should be postponed until after milking.

The dairy byre should be thoroughly disinfected at least several times during the year, and immediately any bacterial trouble appears in the milk. There are various methods.

Milk of lime with carbolic acid is a good wash; 5 per cent carbolic acid is a strong application, but some object to the odour of carbolic. The advantage of this method is that the work may be done with cows in the byre. Bleaching-powder and crude hydrochloric acid (giving off "poison gas") are very effective, but the doors, windows, and other openings must be closed down. The treatment is more effective if all surfaces are first sprayed with water. One pound of powder mixed with 3 lb. of acid should suffice for every 5000 cubic feet. As showing the efficacy of this treatment, we know of a number of instances where the milk had remarkable keeping qualities immediately after the byre had been treated in this way. The vapour of burning sulphur may be utilised in the same way; it does not corrode metal work to the same extent, but is not quite so effective as a disinfectant.

Milkers should wear suitable overalls for the purpose, and these should be regularly washed and boiled. They should also wash the hands in clean water before milking each cow, preferably in running water. No one should milk with hands too wet. If one cannot milk with dry hands one should merely moisten them. Dripping hands should never be allowed in milking.

Milking by machine, when due precautions are observed, prevents much of the bacterial contamination from the atmosphere of the byre and the exterior of the cow. But it is essential that the parts of the machine should be bacteriologically clean. The sediment in machine-drawn milk is on the average only one-tenth that in hand-drawn milk.

Strainers or sieves of different kinds are used to remove as much as possible of the solid dirt particles from milk, but no sieve can be used which will separate bacteria from milk once they have got in.

The temperature at which milk is kept has a profound effect upon the bacterial count. This is shown by the results of the following test. The sample of milk when received at the laboratory contained approximately 10,000 becteria per c.c.:—

	At 59° Fahr. Bacteria per c.c.	At 77° Fahr. Bacteria per c.c.
After 3 hours . .	10,600	20,000
" 6 " . .	25,000	185,000
" 9 " . .	59,000	1,075,000
" 24 " . .	1,630,000	620,970,000

Early cooling of milk is much more effective in keeping down the bacterial content than later cooling. At 40° Fahr. there is very little bacterial change in milk; at 50° Fahr. the changes are slow. Fresh milk cooled to 40° Fahr., and kept

at temperatures between 40° Fahr. and 50° Fahr., may remain practically free from acidity for several days. Yet during this period it may be slowly fermented by bacteria which grow at low temperatures, and which produce bitterness, sliminess, &c., or gradual putrefaction.

In the preservation of milk by heating two terms are employed, according to the degree of temperature: (1) "pasteurising," or heating to scalding temperatures sufficient to destroy the ordinary germ cells; (2) "sterilising," or heating to boiling point or over to destroy all germ life in the milk.

Heating milk alters it in several respects. In the first place, it imparts a cooked or scalded flavour to the milk, which becomes more pronounced as the temperature is increased. Milk heated to 160° Fahr. or over has a distinct scalded flavour. This flavour, however, becomes less perceptible on standing, and it is dissipated more rapidly where the milk is passed over a cooler. Heating to 160° Fahr. or over diminishes to a certain extent the nutritive value of the milk, particularly that of the salts present. Certain of the salts are precipitated or rendered insoluble, the effect being greater at higher temperatures. Sterilised milk is affected more than pasteurised. Scalded milk has a thinner consistency, and invariably appears to be of a slightly poorer quality. Nor does the cream rise so quickly or so completely from pasteurised or sterilised milk.

The bacterial contents are very different in pasteurised milk compared with unpasteurised. Practically the whole of the non-sporing bacteria have been exterminated or rendered inactive, including the milk-souring bacteria and the principal disease-producing bacteria, such as the germs of typhoid, scarlet fever, diphtheria, cholera, and tuberculosis. The germ of tuberculosis is the most resistant in this class. Therefore the death point for this organism should determine the pasteurising temperature. Exposure in milk to 160° Fahr. for a full minute generally destroys this germ. Pasteurised milk keeps sweet much longer than ordinary unpasteurised milk, and the danger of transmitting disease by means of the milk is reduced to a minimum; and for these reasons chiefly the practice of pasteurising milk is extending. Any defect in the salts of pasteurised milk may be made good to a large extent for children and invalids in the form of raw meat or fruit juices, such as flesh, orange, lemon, or beet juices.

General Methods of Dealing with Bacterial Taints.

In dealing with faults in milk or other dairy produce we should first endeavour to ascertain whether the fault is bacterial or non-bacterial in its origin, then proceed to discover the cause

or source of the trouble, and take steps to prevent its recurrence. If the fault is quite evident in the milk of all the cows at the time of milking, it is more likely to come from the food of the cows. But if it becomes pronounced only as the milk becomes older, it is probably due either to germs in the milk or to absorption of taints from the surroundings. If it is due to germs, it can be transferred to pure milk or sterilised milk by inoculation.

If the fault is recognised to be of bacterial origin, and is found in the mixed milk of the herd, it should be ascertained whether it is a general trouble or confined to the milk of one or a few cows. This point may be determined by taking a separate sample from the milk of each cow and making the simple fermentation test described below.

If the cause of the trouble can be traced to one or more cows the remedy is comparatively simple. The milk of the affected cows must be collected separately until the trouble disappears, and the faulty milk should be pasteurised before being mixed with the sound milk. If the fault is found to develop in all the individual samples of milk taken from the cows at the time of milking, infection must be either from the byre, the utensils, the water used during milking in washing the hands, &c., or from the exterior of the cows, as a result of cows wading or splashing in contaminated water. The water used may be tested by the fermentation test described below. In this case a quantity of the suspected water should be added to a larger volume of pure sterile milk. The utensils should be specially disinfected by thorough boiling. The water in the fields may be tested by confining the cows for a few days on different pasture. The byre may be thoroughly disinfected, and in particular the drains in the byre should be cleaned and treated with a strong disinfecting solution.

Fermentation Test.

A simple and very effective fermentation test for faulty milk, which can be carried out with very little trouble in the laboratory, and also with certain modifications in the dairy, is as follows: Clean and dry a sufficient number of ordinary glass test-tubes and plug each tube with a piece of cotton wool. Sterilise by heating in a hot-air oven to a temperature of 270° Fahr., or until the cotton wool begins to turn slightly brown. Pour milk from each sample to be tested into one of the test-tubes until the tube is about three-quarters full, and again insert the cotton-wool plug. Place the tubes of milk in an incubator at 104° Fahr. Examine at the end of 24, 36, and 48 hours respec-

tively, and make careful notes of the appearance and odour of each sample.

Ordinarily pure milk at the end of 24 hours should be firmly coagulated into a close, uniform coagulum free from gasiness or liquefaction (dissolving of curd into a watery solution), and it should have a pleasing aroma.

But if the coagulum is torn by gas bubbles it indicates the presence of an abnormally large number of gas-producing bacteria, probably intestinal bacteria from dung.

If the milk has not coagulated in 24 hours, but is still in the milky condition, it indicates the presence of an abnormal number of putrefactive bacteria of the liquefying, alkaline-producing species. If these samples are examined again at the end of 48 hours, it will probably be found that a weak coagulum has formed and has been partially liquefied to a yellowish liquid with a disagreeable odour. This condition indicates the presence of an unusual number of liquefying putrefactive germs or of inflammatory germs from diseased udders.

When testing for ropy or slimy milk, the test-tubes containing the samples should be kept at ordinary air temperatures (60° Fahr.) and examined at intervals during several days.

REPORT ON AN EXPERIMENT ON THE MANURING OF OATS.

By PRINCIPAL W. G. R. PATERSON, B.Sc., West of Scotland Agricultural College.

Introductory.

THE variation in the yield of the Oat crop per acre from year to year is at times so pronounced that one is apt to give scarcely due consideration to some of the other factors affecting the yield. In these days, however, when the necessity of getting as much food as possible from every acre of land has been brought so vividly to our notice, the other factors affecting the yield of the Oat crop claim special attention—and while manuring is only one of these factors, it is a very important one, and to-day assumes greater importance than ever before.

No doubt the production of Oats might be greatly increased by putting a larger area under the plough, and in this respect there is good reason to believe that the special effort made in recent months will be renewed in another season. Apart, however, from the possibility of increasing the yield by increasing the area under this crop, it is undoubtedly the case that the average yield per acre might be considerably raised by judicious manuring.

The average yield per acre of Oats in Scotland over the last ten years was approximately 38 bushels. Compared with other countries, and taking soil and climate into account, this yield is not unsatisfactory, but nevertheless it is a long way short of the possible yield.

The following table gives the approximate acreage and average yield of the Oat crop in different countries over a five years' period, 1909 to 1913 inclusive. Since the outbreak of war there has in some cases been a very considerable increase in the area under this crop, while in other cases there has been a reduction.

Country.	Approximate Area under Crop. (Acres.)	Yield per Acre. (Bushels).
United Kingdom	4,090,000	43
England and Wales	2,065,000	41 35
Scotland	963,000	38
Ireland	1,062,000	49
Belgium	623,000	56
Netherlands	345,000	48
Switzerland	100,000	47
Germany	10,800,000	44
Denmark	1,032,000	43
Norway	265,000	36
Japan	112,000	36
Sweden	1,970,000	34
France	9,700,000	30
Austria	4,600,000	29
Canada	10,000,000	29
United States	37,000,000	25
Italy	1,250,000	24
Roumania	1,110,000	21
Russia (in Europe)	42,000,000	18
Spain	1,285,000	18

Numerous experiments on the manuring of Oats have now been conducted, and the requirements of this crop in the way of manurial ingredients are already well known. Nevertheless, when we consider the average yield per acre for Scotland, and at the same time think of the yields per acre actually obtained on many farms, that from point of view of soil and climate could at best be classed only as second rate, we cannot but conclude that manuring the Oat crop is not nearly so widely practised as it might with advantage be.

In order that the Oat crop may benefit to the fullest extent from the application of manure, it is essential that the soil contain a fair balance of lime, because of the varied and all-important part played by that substance. In addition to keeping up a supply of lime we must provide in sufficient amount suitable compounds of Nitrogen, Phosphate, and Potash.

The actual part played by each of these ingredients has now

been pretty well established. We know, for example, that the Phosphate plays a very important part throughout the whole period of growth from start to finish. It enables the young Oat plant to develop root more quickly and get over what is known as the "sitting" stage. It has also a marked effect in promoting tillering, so that on land well stored with Phosphates, if a tillering variety of Oat is sown, a smaller quantity of seed will suffice. Being more intimately connected with seed formation than with production of leaf and stem, the Phosphate, provided the other ingredients are available in sufficient amount, tends to make the crop much more fruitful. It has a marked effect in increasing the number of grains on each head, and without this ingredient the same increase never takes place. In addition, the Phosphate tends to hasten the ripening of the crop, which effect, though occasionally a slight disadvantage in a dry season, is undoubtedly of very great importance in a late season or in late districts.

The part played by Potash is also well known, and this is always a specially important ingredient for crops which produce much starch or sugar. It plays a part in connection with Carbon Assimilation which is the starting-point for the formation of starch and sugar in the plant, and because of this it tends to give plump well-filled grain.

The Phosphate undoubtedly has an effect in increasing the number of grains, but the Potash is in great measure responsible for the full development of these.

Further, it tends to strengthen the straw of the Oat crop, with the result that the crop does not lodge so readily. This effect is very important where a big yield per acre is aimed at. It has also an effect on the health of the plant, the crop being less liable to fungoid and certain other diseases. In a dry season particularly it rather tends to prolong the growth, and to some extent counteracts the effect of the Phosphate.

In some respects Nitrogen plays the most important part of all the manurial ingredients, for, if deficient, growth is always poor and stunted. It has a very marked effect on rate of growth, and has much to do with the production of leaf and stem. Too liberal a use of Nitrogen makes the crop more liable to lodge, as it is drawn up too quickly. It also rather delays ripening. When applied in moderate quantity, and along with Phosphate and Potash, the result is the very reverse, for not only does the crop ripen earlier but it also stands up much better.

Many farmers hesitate to manure their Oats because they are afraid that the application of manure will greatly encourage lodging. If the quantity of Nitrogen is kept in moderation

they need have no fears on that score, as a well-balanced manure strengthens the crop and enables it to stand up much better. A worthy and very wide-awake farmer in the south of Scotland once assured the writer that until he commenced to manure his "Red land" Oats they were almost always down at harvest time, but he had found from experience that it was because they had not strength to stand up.

This effect of manuring was very noticeable in the results obtained in 1915 and 1916 on some of the Demonstration Areas under the West of Scotland Agricultural College. At Lockerbie, for example, six acres were fully manured with Superphosphate, Potash, and a little Sulphate of Ammonia, and 1½ acres were unmanured. The yield was considerably higher on the manured portion, yet in spite of that this part of the field stood up very much better than the unmanured part.

At Biggar Demonstration Area last season a very similar result was obtained, although Salt was used in place of Potash. The crop was practically all standing, and yet the yield was nearly 50 per cent above the average yield for Scotland.

Manuring will undoubtedly encourage lodging of the Oat crop if too much Nitrogen is applied, but if a fair dressing of Phosphate and Potash—or some substance, such as Salt, to liberate the soil Potash when Potash manures are not available—be given, and the Nitrogen be used in moderate amount, or omitted altogether under exceptional conditions, as when rich old pasture land or grass land full of clover is broken up, there is no great risk of trouble on that score.

In the following pages a short account is given of some experiments commenced by the West of Scotland Agricultural College in 1912. The experiments were continued in 1913 and 1914, but had to be discontinued from 1915 on account of the war.

The investigation is by no means complete, but the results already obtained are of considerable value, in that they show to what extent the yield of the Oat crop is likely to be increased by the judicious application of artificial manures.

The experiments were carried out on selected farms pretty widely scattered and fairly representative of the area served by the College. A wide variety of soils were represented, but on every farm special care was taken to select for the experiment what seemed to be a uniform area.

The plots on which the experiments were conducted were each one-tenth of an acre in extent. A uniform quantity of seed was applied to each plot, and the plots were treated exactly alike in all respects save that of manurial treatment.

The scheme of manuring was as follows[1]:—

Plot.	Manure applied per acre.	
I.	Unmanured.	
II.	2 cwt. Superphosphate, 30%	Harrowed in at time of seeding.
III.	2 cwt. Superphosphate 2 cwt. Kainit	Harrowed in at time of seeding.
IV.	2 cwt. Superphosphate 2 cwt. Kainit	Harrowed in at time of seeding.
	1 cwt. Nitrate of Soda	Applied as a top-dressing when crop has brairded.
V.	2 cwt. Superphosphate 2 cwt. Kainit	Harrowed in at time of seeding.
	134 lb. Nitrate of Lime	Applied as a top-dressing when crop has brairded.
VI.	2 cwt. Superphosphate 2 cwt. Kainit 87 lb. Sulphate of Ammonia	Harrowed in at time of seeding.
VII.	2 cwt. Superphosphate 2 cwt. Kainit 97 lb. Nitrolim	Harrowed in at time of seeding.

The Nitrate of Lime, Sulphate of Ammonia, and Nitrolim supplied exactly the same amount of Nitrogen as was contained in 1 cwt. of Nitrate of Soda.

As will be seen from the scheme of manuring, all the manures were harrowed in at the time of seeding excepting the Nitrate of Soda and the Nitrate of Lime, which, being rather quicker in their action than the other nitrogenous manures, were top-dressed just after the Oats had brairded.

The experiment was designed for the purpose of ascertaining what increase in yield might reasonably be expected from the application of a fair dressing of artificials under ordinary conditions, and also with a view to noting the relative effects of the four nitrogenous manures—Nitrate of Soda, Nitrate of Lime, Sulphate of Ammonia, and Nitrolim—when applied at equivalent rates of Nitrogen, and when used along with Superphosphate and Kainit.

In each of the years in which the experiments were conducted, in spite of very careful working, a number of results had to be discarded owing to varying circumstances over many of which the experimenters had no control, but a total of 17 complete and very reliable returns were obtained: 7 in 1912, 5 in 1913, and 5 in 1914.

The farms from which complete and reliable returns were

[1] In the carrying out of the experiment in the field the order of the plots was slightly different to what is indicated here. The present arrangement was adopted for sake of simplicity, as it shows more clearly the increase due to manuring.

obtained, the nature of the soil at each centre, and the previous crops were as follows:—

Season.	Centre.	Nature of Soil.	Previous Crop
1912.	Blairgorts, Stirlingshire.	Sandy loam.	Turnips.
"	Davington, Langholm, Dumfriesshire.	Light loam.	Pasture.
"	Garden, Port of Menteith, Stirlingshire.	Carse land.	Turnips.
"	Harelawhill, Canonbie, Dumfriesshire.	Stiff loam.	Turnips.
"	Henshilwood, Carnwath, Lanarkshire.	Loam.	Turnips.
"	High Borland, Eaglesham, Renfrewshire.	Light gravelly soil.	Potatoes.
"	Newfield, Dalry, Kirkcudbright.	Medium loam.	Pasture.
1913.	Fingart, Dunlop, Ayrshire.	Peat over clay.	Oats.
"	Kells of Southwick, Kirkcudbright.	Sharp soil.	Turnips.
"	Raithhill, Coylton, Ayrshire.	Poor till.	Oats.
"	The Lodge, Slamannan.	Medium loam.	Pasture.
"	Whole Flats, Grangemouth, Stirlingshire.	Carse land.	Pasture.
1914.	Avonbridge, Kippen, Stirlingshire.	Medium loam.	Oats.
"	Ducherain, Lochgilphead, Argyll.	Medium loam.	Pasture.
"	East Flanders, Stirlingshire.	Stiff carseland.	Oats.
"	Headswood, Denny, Stirlingshire.	Light loam.	Pasture.
"	Raeburnfoot, Gretna, Dumfriesshire.	Red loam.	Pasture.

For Summary of Results see page 188.

Notes on the Results.

The larger yield of straw per acre in 1912, as compared with 1913 and 1914, was no doubt in great measure due to the fact that in 1912 the month of April was one of the best on record. It was on the whole the finest month of the year. The Oat crop was put in under ideal conditions, and made specially good progress in that month. May was on the whole also a favourable month, but the rainfall in June was considerably above the normal. July was a seasonable month, but August was cold and changeable and ripening made but little progress, the result at harvest being a moderate yield of grain and a large yield of straw.

SUMMARY OF RESULTS OBTAINED IN THE DIFFERENT SEASONS.

Plot.	Average yield of grain.	Increase over unmanured plot.	Average yield of straw.	Increase over unmanured plot.	Manure applied.
Season 1912.					
	Bushels.	Bushels.	Cwt.	Cwt.	
I.	39	—	35¼	—	None.
II.	41¼	2¼	37½	2¼	Superphosphate.
III.	43¾	4¾	39¼	4	Superphosphate and Kainit.
IV.	50	11	49	13¾	Superphosphate, Kainit, and Nitrate of Soda.
V.	52	13	49¼	14	Superphosphate, Kainit, and Nitrate of Lime.
VI.	50¾	11¾	46¼	11	Superphosphate, Kainit, and Sulphate of Ammonia.
VII.	50½	11½	44	8¾	Superphosphate, Kainit, and Nitrolim.
Season 1913.					
I.	37½	—	25	—	None.
II.	40½	3	26¼	1¼	Superphosphate.
III.	42¾	5¼	28¾	3¾	Superphosphate and Kainit.
IV.	49	11½	30¼	5¼	Superphosphate, Kainit, and Nitrate of Soda.
V.	51	13½	33½	8½	Superphosphate, Kainit, and Nitrate of Lime.
VI.	52½	15	36¾	11¾	Superphosphate, Kainit, and Sulphate of Ammonia.
VII.	50	12½	36½	11½	Superphosphate, Kainit, and Nitrolim.
Season 1914.					
I.	48	—	22	—	None.
II.	49¼	1¼	21	(−1)	Superphosphate.
III.	53¼	5¼	24	2	Superphosphate and Kainit.
IV.	62½	14½	30	8	Superphosphate, Kainit, and Nitrate of Soda.
V.	61¼	13¼	27½	5½	Superphosphate, Kainit, and Nitrate of Lime.
VI.	61½	13½	29	7	Superphosphate, Kainit, and Sulphate of Ammonia.
VII.	55½	7½	26¼	4¼	Superphosphate, Kainit, and Nitrolim.

The relatively large yield of grain and the smaller yield of straw in 1914 is again due to the season. The month of June, instead of being wet as in 1912, was exceptionally dry, being one of the driest on record, and the latter part of the month was very warm. In July the rainfall was again below the normal and the temperature above normal. The production of straw suffered to some extent on that account, but the crop ripened under favourable conditions. The harvest was an early one, and the yield of grain per acre considerably above the normal.

Although seasonal variation is very important, the summary of results for the years 1912, 1913, and 1914 shows clearly that the increases due to the application of manures were very similar in each of these years, especially as regards the production of grain.

The following table gives the average yield over the three seasons 1912, 1913, and 1914 from the seventeen experiments:—

Plot.	Average yield of grain.	Increase over unmanured plot.	Average yield of straw.	Increase over unmanured plot.	Manure applied.
	Bushels.	Bushels.	Cwt.	Cwt.	
I.	41¼	—	28¼	—	None.
II.	43½	2¼	29½	1¼	Superphosphate.
III.	46¼	5	31¾	3½	Superphosphate and Kainit.
IV.	53½	12¼	38	9¾	Superphosphate, Kainit, and Nitrate of Soda.
V.	54½	13¼	38¼	10	Superphosphate, Kainit, and Nitrate of Lime.
VI.	54½	13¼	38½	10¼	Superphosphate, Kainit, and Sulphate of Ammonia.
VII.	51¾	10½	36½	8¼	Superphosphate, Kainit, and Nitrolim.

In view of the above, on the average of seasons and under normal conditions, one may reasonably expect an application of 2 cwt. of Superphosphate (30 per cent) per acre to increase the yield of the Oat crop over the average production of similar unmanured areas by about 2¼ bushels grain and 1¼ cwt. of straw.

An application of 2 cwt. Superphosphate and 2 cwt. Kainit under similar conditions will be likely to increase the yield to the extent of 5 bushels of grain and 3½ cwt. of straw; while a complete dressing, including 2 cwt. Superphosphate, 2 cwt. Kainit, and a nitrogenous manure equivalent to 1 cwt. Nitrate of Soda may be expected to increase the yield by as much as 12 bushels of grain and about 10 cwt. of straw per acre.

MILK RECORDS.

FOURTEENTH YEAR—RECORDS OF 22,702 COWS.

By WILLIAM STEVENSON, B.Sc., N.D.A., N.D.D., Superintendent of Milk Records to the Scottish Milk Records Association.

SYSTEMATIC Milk Recording in Scotland was continued in 1916 on the same lines as in 1915 and previous years. The work was carried on under the direction of The Scottish Milk Records Association as formerly.

The Association in 1916 consisted of the following members:—

Name and Address.	Body Represented.
Mr J. S. Paterson, Quhytewoollen, Lockerbie	Annandale Milk Record Society.
Mr William Niven, Smithstone, Maybole	Ayr and Stair Milk Record Society.
Mr W. D. M'Cubbin, Lochlands, Maybole	Carrick Milk Record Society.
Mr John Young, Skerrington Mains, Hurlford	Central Ayrshire No. 1 Milk Record Society.
Mr James Symington, Kersepark, Hollybush	Coylton and District Milk Record Society.
Mr John Sloan, Creoch, New Cumnock	Cumnock Milk Record Society.
Mr Robert Howie, Drumfork, Helensburgh	Dumbartonshire Milk Record Society.
Mr James Osborne, Ryemuir, Lochmaben	Dumfries and District Milk Record Society.
Mr John Murray, Kilfillan, Glenluce	Dunragit Milk Record Society.
Mr David Sillars, Low Todhill, Fenwick	High Fenwick Milk Record Society.
Mr J. W. Miller, Lochhead, West Wemyss	Fife Milk Record Society.
Mr J. Finnie, Camphill, Dalry	"John Speir" Milk Record Society.

Name and Address.	Body Represented.
Mr S. Mitchell, Killeonan, Campbeltown	Kintyre and Islay Milk Record Society.
Mr Robert Paton, Mains of Airies, Stranraer	Kirkcolm and District Milk Record Society.
Mr John M'Caig, Belmont, Stranraer	Kirkcolm and Leswalt Milk Record Society.
Mr W. M. Menzies, Estate Office, Ardwell, Stranraer	Kirkmaiden & Stoneykirk Milk Record Society.
Mr Gavin Hamilton, British Linen Bank, Lesmahagow	Lesmahagow Milk Record Society.
Mr Alex. Edgar, Chapelheron, Whithorn	Lower Wigtownshire Milk Record Society.
Mr William Wallace, Auchenbrain, Mauchline	Mauchline Milk Record Society.
Mr Thomas Barr, Hobsland, Monkton	Monkton and District Milk Record Society.
Mr David Goldie, Little Shewalton, Irvine	Montgomerie Milk Record Society.
Mr James Moffat, Gateside, Sanquhar	Nithsdale Milk Record Society.
Mr John A. Carlyle, 2 Addison Place, Arbroath	North of Scotland Milk Record Society.
Mr A. Wilson, Finlaystone, Ochiltree	Ochiltree Milk Record Society.
Mr Robert Wilson, Craig, Neilston	Renfrewshire (Upper Ward) Milk Record Society.
Major J. A. Houison-Craufurd, Dunlop House, Dunlop	Stewarton and Dunlop Milk Record Society.
Mr H. W. B. Crawford, Chapmanton, Castle-Douglas Mr W. P. Gilmour, Balmangan, Kirkcudbright	Stewartry of Kirkcudbright Milk Record Society, Circuits Nos. 1 and 2.
Mr Thomas Clement, of Netherton, 64 Albion Street, Glasgow Mr James Howie, Hillhouse, Kilmarnock Mr Thomas C. Lindsay, Aitkenbrae, Monkton Mr A. W. Montgomerie, Lessnessock, Ochiltree	The Ayrshire Cattle Herd-Book Society.

operated in 1916, with the name and address of the secretary of each society:—

Name of the Society.	Secretary.
Annandale	Mr John Henderson, Banker, Lockerbie.
Ayr and Stair	Mr Quintin Dunlop, Greenan, Ayr.
Carrick	Mr John Stevenson, jun., Balig, Ballantrae.
Central Ayrshire No. 1	Mr James Howie, Hillhouse, Kilmarnock.
Coylton and District	Mr William Logan, Southcraig, Patna.
Cumnock	Mr Alex. Arthur, Benston, New Cumnock.
Dumbartonshire	Mr John Bilsland, Quay Place, Dumbarton.
Dumfries and District	Mr John Henderson, Banker, Lockerbie.
Dunragit	Mr T. Campbell Gilmour, Estate Office, Dunragit.
Fenwick (High)	Mr James Mather, Low Gainford, Fenwick.
Fife	Mr Wm. Macniven, Royal Bank, Kirkcaldy.
"John Speir"	Mr William Longwill, Hawhill, Dalry.
Kintyre and Islay	Mr A. S. Paterson, Royal Bank, Campbeltown.
Kirkcolm and District	Mr James A. Gilmour, Southcairn, Stranraer.
Kirkcolm and Leswalt	Mr John M'Caig, Belmont, Stranraer.
Kirkmaiden & Stoneykirk	Mr William Findlay, Cairnhandy, Ardwell.
Lesmahagow	Mr Gavin Hamilton, British Linen Bank, Lesmahagow.
Lower Wigtownshire	Mr William Christison, Barglass, Kirkinner.
Mauchline	Mr Wm. Wallace, Auchenbrain, Mauchline.
Monkton and District	Mr William Howie, Brieryside, Monkton.
Montgomerie	Mr David Goldie, Little Shewalton, Irvine.
Nithsdale	Mr John Henderson, Banker, Lockerbie.
North of Scotland	Mr John A. Carlyle, 2 Addison Place, Arbroath.
Ochiltree	Mr A. W. Montgomerie, Lessnessock, Ochiltree.
Renfrewshire (Upper Ward)	Mr J. Campbell Murray, 216 West George Street, Glasgow.
Stewarton and Dunlop	Mr John Littlejohn, Buistonend, Kilmaurs.
Stewartry Nos. 1 and 2	Mr Patrick Gifford, Solicitor, Castle-Douglas.

Season 1916.

The following table shows for each Society the number of members, the number of cows tested, the interval between the tests, and the duration of the recording season:—

Name of the Society.	No. of Members.	Number of Cows Tested.	Interval between Tests, in days.	Duration of Recording Season, in weeks.
1. Annandale	23	950	27	52
2. Ayr and Stair . . .	16	725	21	52
3. Carrick	13	584	21	52
4. Central Ayrshire, No. 1 .	18	635	21	52
5. Coylton and District . .	19	501	20	52
6. Cumnock	18	654	21	52
7. Dumbartonshire . .	14	570	17	52
8. Dumfries and District .	18	673	21	52
9. Dunragit	16	1064	21	51
10. Fenwick (High) . .	27	954	28	52
11. Fife	17	706	20	52
12. "John Speir" . . .	27	718	28	52
13. Kintyre and Islay . .	18	740	28	42
14. Kirkcolm and District .	15	943	21	47
15. Kirkcolm and Leswalt .	18	1033	21	50
16. Kirkmaiden and Stoneykirk	18	1367	21	44
17. Lesmahagow	23	625	28	52
18. Lower Wigtownshire . .	23	1230	28	52
19. Mauchline	18	618	20	52
20. Monkton and District .	19	818	21	52
21. Montgomerie	23	751	28	52
22. Nithsdale	22	910	27	52
23. North of Scotland . .	9	369	28	52
24. Ochiltree	17	482	20	52
25. Renfrewshire (Upper Ward)	15	597	20	52
26. Stewarton and Dunlop .	26	972	28	52
27. Stewartry, No. 1 . .	20	1130	24	52
28. Stewartry, No. 2 . .	23	1383	28	52
Total No. .	533	22,702		

Definitions.

The milk records compiled by the Association are records of the estimated quantity of milk produced by each cow in a

separate lactation, and of the estimated percentage of milk-fat contained in the milk. For convenience a gallon of milk is reckoned as 10 lbs. A gallon of milk of average quality weighs almost exactly 10⅓ lbs. The following further particulars concerning each record are also given, wherever possible:—

Name of cow, byre number, and herd-book number.
Sire of cow, and herd-book number of sire.
Dam of cow, and herd-book number of dam.
Age of cow at opening of record.
Date of calving preceding opening of record.
Number of weeks in milk.
Date of next calving after record closed.

The following particulars of *the preceding record* are appended to each record, where available:—

Date of calving preceding opening of record.
Quantity of milk in gallons.
Percentage of fat in milk.
Number of weeks in milk.

The milk yields were estimated in respect of quantity and milk-fat percentage from the results of systematic periodic tests by trained recorders. The recorders visited the farms for this purpose at intervals varying from 14 to not more than 28 days, and each day of visit was regarded as the middle day of the period covered by the visit. Milk records estimated in this way approximate closely to the actual milk yields.

Classification of Records.

The records were classified into three groups for cows and heifers respectively, on the same basis as in the last six annual reports. Experience has confirmed the view that a very useful comparison is obtained by reckoning the yields at their estimated equivalent in milk of 1 per cent of milk-fat. Such a comparison takes into consideration both the quantity and quality of the milk.

Cows with a milk record equivalent to not less than 2500 gallons at 1 per cent of fat, and heifers with a milk record equivalent to not less than 2000 gallons at 1 per cent of fat, were grouped into Class I. Cows and heifers with milk records of less than two-thirds of these amounts—*i.e.*, 1660 and 1330 gallons respectively—were grouped into Class III.

The following short table shows the corresponding values of these yields in fairly good milk of 3·5 per cent milk-fat:—

Class.	Yield in Milk of 1 Per Cent Fat. (Gallons.)	Corresponding Yield in Milk of 3·5 Per Cent Fat. (Gallons.)
Cows in Class I. .	Not less than 2500	714
Heifers in Class I. .	Not less than 2000	571
Cows in Class III. .	Less than 1660	474
Heifers in Class III.	Less than 1330	380

All cows and heifers with milk yields falling between these limits would come into Class II. Such animals naturally claim less attention than the good milkers or the obviously unprofitable animals. In order to economise space, particulars of their records are not included in this report.

It should always be kept in mind, when making a comparison of cows in different herds or in different districts, that the different conditions of soil and climate and the different methods of dairying practised have a considerable influence on the milk yields, and that therefore milk yields alone do not necessarily indicate the true relative inherent or hereditary milking qualities of the animals. But the authenticated milk records compiled by the Association ought to be of inestimable value to breeders and owners of dairy cows if properly interpreted.

Milk Record Societies approved by The Scottish Milk Records Association in 1916.

Annandale Milk Record Society.

This society was in its fifth year, and consisted of 23 members, as in the four previous years—the maximum number that could be conveniently served by one recorder on a 27 days' circuit. The number of cows tested was 950, practically the same number as in 1915.

On some of the farms in this district milk is produced for direct sale, and cows calve at all seasons of the year. On other farms cheese is made during the summer months, and most of the cows calve in spring.

Recording was carried on throughout the whole year, the recorder visiting each farm at intervals of 27 days. One advantage of 27 as compared with 28 days' tests is that each

member has the visit of the recorder on a different day of the week on each round.

Of the 950 cows and heifers tested by this society, 510 cows and 163 heifers were included in Class I., and 18 cows and 3 heifers in Class III. Thus, of the total cows and heifers tested 71 per cent were placed in Class I. and 2 per cent in Class III., compared with 75 per cent and 2 per cent respectively in 1915; but an improvement of 13 per cent and 2 per cent respectively from 1914.

Ayr and Stair Milk Record Society.

This society was in its second year. The number of members was 16, one less than in the previous year, and two less than the full membership for a society conducting 21 days' tests. The number of cows tested was 725, an increase of 49 from 1915.

On some of the farms in this district cheese is made during the summer months. On other farms milk is produced for direct sale, and a considerable proportion of the cows calve in autumn or winter.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 21 days.

Of the 725 cows and heifers tested by this society, 280 cows and 141 heifers were included in Class I., and 28 cows and 11 heifers in Class III. Thus, of the total cows and heifers tested, 58 per cent were placed in Class I. and 5 per cent in Class III., an improvement of 9 per cent and 0 per cent respectively from 1915.

Carrick Milk Record Society.

This society was in its ninth year. The number of members in 1916 was 13, three less than in the previous year. Two of the herds, however, were very large, and required more than one day's testing on each visit. In order to avoid the necessity of having the recorder at these two farms two days on each round, it was arranged that the arithmetical and clerical work should be done in the superintendent's office. The recorder to this society left to join the Army in April, and a woman-recorder was appointed. Unfortunately, two of the members made this appointment a reason for discontinuing recording from April. Thus, only 11 members completed the season's recording. The spare time of the new recorder was utilised in the superintendent's office on the byre sheets and record-books of a number of the larger herds of other societies. The total number of cows tested by the society in 1916 was 584.

The members of this society were widely scattered from

Maybole to beyond Ballantrae. On most of the farms cheese is made during the spring and summer months, but on some of the farms nearer to railway stations milk is produced for direct sale. Cows calve at all seasons, but the majority calve in spring.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 21 days.

Of the 584 cows and heifers tested by this society, 175 cows and 60 heifers were included in Class I., and 33 cows and 4 heifers in Class III. Of the total cows and heifers tested, excluding the two herds not tested to the end of the recording season, 47 per cent were placed in Class I. and 7 per cent in Class III., an improvement of 10 per cent and 2 per cent respectively from 1915.

Central Ayrshire No. 1 *Milk Record Society.*

(Hurlford, Galston, and Newmilns Districts.)

This society was in its ninth year. The 18 original members in 1908 were widely scattered from near Ayr to beyond Kilmarnock, but since 1913, owing to the formation of other two societies in Central Ayrshire, the No. 1 Society has been confined chiefly to the Hurlford, Galston, and Newmilns districts. The number of members in 1916 was 18, one more than in the previous year, and the full membership of the society. The number of cows tested was 635.

On most of the farms milk is produced for direct sale, but in a few cases cheese is made during the summer months. On the majority of the farms cows are calving at all periods of the year.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 21 days.

Of the 635 cows and heifers tested by this society, 300 cows and 63 heifers were included in Class I., and 31 cows and 1 heifer in Class III. Thus, of the total cows and heifers tested, 57 per cent were placed in Class I. and 5 per cent in Class III., an improvement of 8 per cent and 2 per cent respectively from 1915.

Coylton and District Milk Record Society.

This society was in its third year. The number of members in 1916 was 19, two more than in the previous year, and two more than the full membership of a society conducting tests at intervals of 20 days. In 1915 the society agreed to change the interval between tests from 21 days to 20 days. Testing at intervals of 20 days offers several advantages. Each member

has the visit of the recorder on a different day of the week on each round, while the interval between tests is not unduly long so as to interfere with the reliability of the records; also calculating is simplified, as each half pound of milk daily represents one gallon in 20 days. The number of cows tested in 1916 was 501, an increase of 15 from the previous year.

On most of the farms in this district cheese is made during the summer season. On a few of the farms milk is produced for direct sale all the year round.

Recording was continued throughout the whole year. The recorder visited each farm at intervals of 20 days.

Of the 501 cows and heifers tested by this society, 320 cows and 92 heifers were included in Class I., and 10 cows but no heifers in Class III. Thus, of the total cows and heifers tested, 82 per cent were placed in Class I. and 2 per cent in Class III., compared with 85 per cent and 2 per cent respectively in 1915; and with 62 per cent and 4 per cent respectively in 1914.

The Coylton and District Society had the distinction of having the largest percentage of animals eligible for Class I. of all the societies in 1915 and in 1916.

Cumnock Milk Record Society.

The Cumnock Society is one of the two milk record societies in Scotland which have operated continuously since 1905, and have completed twelve years of recording, though some of the members of the original Cumnock Society are now members of other societies, while new members in the more immediate neighbourhood have come in. The number of members in 1916 was 18, the full membership of the society. The number of cows tested was 654, an increase of 34 from 1915.

The great majority of the cows in this district calve in the early spring, and cheese-making is general during the summer season. On some of the farms milk is sold during the autumn and winter months, and some of the cows calve towards the end of the year.

Recording was continued throughout the whole year. The recorder visited each farm at intervals of 21 days.

Of the 654 cows and heifers tested by this society, 318 cows and 150 heifers were included in Class I., and 7 cows and 1 heifer in Class III. Thus, of the total cows and heifers tested, 72 per cent were placed in Class I. and 1 per cent in Class III.; an improvement of 13 per cent and 1 per cent respectively from 1915; and of no less than 25 per cent and 3 per cent respectively from 1914.

Dumbartonshire Milk Record Society.

This society was in its fourth year. The number of members in 1916 was 14, a decrease of three members from 1915, and three less than the full membership of the society. The number of cows tested was 570, a decrease of 147 from the previous year.

In this district milk is sold all the year round, and cows calve at all seasons.

Recording was carried on during the whole year. The recorder visited each farm at intervals of 17 days.

Of the 570 cows and heifers tested by this society, 236 cows and 89 heifers were included in Class I., and 19 cows and 6 heifers in Class III. Thus, of the total cows and heifers tested, 57 per cent were placed in Class I. and 4 per cent in Class III.; an improvement of no less than 21 per cent and 2 per cent respectively from 1915.

Dumfries and District Milk Record Society.

This society was in its second year. The number of members was 18, the same number as in the previous year, and the full membership of the society. One of the herds was very large, and in this case it was arranged that the arithmetical and clerical work should be done in the superintendent's office. The number of cows tested was 673.

Most of the members of this society make cheese during the summer season, and the majority of the cows calve in spring. On some of the farms milk is produced for direct sale all the year round, and cows calve at all seasons.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 21 days.

Of the 673 cows and heifers tested by this society, 190 cows and 80 heifers were included in Class I., and 47 cows and 13 heifers in Class III. Of the total cows and heifers tested, 40 per cent were placed in Class I., and 9 per cent in Class III.; an improvement of no less than 25 per cent and 5 per cent respectively from 1915, the first year of the society.

Dunragit Milk Record Society.

This society was inaugurated in 1908 and was in its ninth year, though only four of the original members in 1908 were to be found in the same society in 1916. The number of members in 1916 was 15, the same number as in the previous year, and four of the herds required two days' testing on each visit. The

number of cows tested was 1064, the largest number tested by one recorder on a 21 days' circuit in 1916.

The district is mainly a cheese-making one, and the great majority of the cows calve in early spring, though on some of the farms a proportion calve in autumn or winter.

The records dated from the beginning of January, and covered the whole year, with the exception of a week at the end of December, when very few cows were in milk. The recorder visited each farm at intervals of 21 days.

Of the 1064 cows and heifers tested by this society, 546 cows and 104 heifers were included in Class I., and 5 cows and 2 heifers in Class III. Thus, of the total cows and heifers tested, 61 per cent were placed in Class I. and less than 1 per cent in Class III.; an improvement of 13 per cent and 1 per cent respectively from 1915; and of no less than 27 per cent and 6 per cent respectively from 1914.

Fenwick (High) Milk Record Society.

A milk record society has been in operation in the Fenwick district since 1905. In 1913 the large number of new applicants could not all be accommodated in one society, so the district was divided and two societies formed—the High Fenwick Society and the Laigh Fenwick Society. At the end of 1915, mainly with a view to economy during the war, it was resolved to revert temporarily to the former arrangement of one larger society conducting 28 days' tests. The number of members in 1916 was 27, three more than the full membership, and two former members of the Laigh Fenwick Society were accommodated in the neighbouring Monkton and District Society. The High Fenwick Society had the largest number of members of all local societies in 1916. The number of cows tested by the society was 954.

The milk produced by the members of this society is chiefly for direct sale or butter-making, and cows calve at all periods of the year.

Recording was carried on during the whole year. The recorder visited each farm at intervals of 28 days.

Of the 954 cows and heifers tested by this society, 383 cows and 184 heifers were included in Class I., and 17 cows and 9 heifers in Class III. Thus, of the total cows and heifers tested, 59 per cent were placed in Class I. and 3 per cent in Class III.; an improvement of 6 per cent and 0 per cent respectively, compared with the average results of the two Fenwick Societies in 1915.

The Fife Milk Record Society.

This society was in its fourth year. The number of members in 1916 was 17, the same number as in the previous year, and the full membership for a society conducting 20 days' tests. The number of cows tested was 706, practically the same number as in 1915.

Practically the whole of the milk produced in this district is for direct sale, and cows calve all the year round.

Recording was continued during the whole year. The recorder visited each farm at intervals of 20 days.

Of the 706 cows and heifers tested by this society, 363 cows and 93 heifers were included in Class I., and 25 cows and 1 heifer in Class III. Thus, of the total cows and heifers tested, 65 per cent were placed in Class I. and 4 per cent in Class III., compared with 53 per cent and 3 per cent respectively in 1915; an improvement of 12 per cent in Class I.

"John Speir" Milk Record Society.

(Dalry and Kilbirnie Districts.)

This society was instituted in 1910, and at that time the members were scattered over a very wide dairying district, or series of districts, from Dundonald and Kilmarnock in the south to as far as Dumbarton and Helensburgh in the north. Original members of this society are now included in a number of other local societies. In 1916 the society was in its seventh year. The membership was confined mainly to the Dalry and Kilbirnie districts of Ayrshire. The number of members at the beginning of the year was 25, the same number as in the previous year. Five members withdrew from the society in April following on the appointment of a woman-recorder, and two new members were taken in. The number of members who continued recording to the end of the season was 22. The total number of cows tested by the society in 1916 was 718, practically the same number as in the previous year.

Practically the whole of the milk produced by the members of this society is for direct sale, and cows calve at all seasons.

Recording was continued during the whole year. The recorder visited each farm at intervals of 28 days.

Of the 718 cows and heifers tested by this society, 182 cows and 81 heifers were included in Class I., and 15 cows and 10 heifers in Class III. Of the total cows and heifers tested, excluding the five herds not tested to the end of the season, 44 per cent were placed in Class I. and 4 per cent in Class III.; an improvement of 5 per cent and 6 per cent respectively from 1915.

Kintyre and Islay Milk Record Society.

From 1912 to 1914 inclusive, Kintyre and Islay each had their own milk recording society conducting 21 days' tests, but owing to the resignation of members in both districts at the end of 1914, on the ground of expense, it was resolved to amalgamate the two societies in 1915 and form one joint 28 days' society. The joint society was continued in 1916. The number of members was 18—11 in Kintyre and 7 in Islay—6 less than the total membership in 1915. The number of cows tested was 740, compared with 951 in the previous year.

In Kintyre and Islay there is a very limited market for sweet milk, and practically the whole of the surplus milk produced is made into cheese. Most of the cows calve in the spring months.

The records dated from 13th February, and covered a period of 42 weeks. The recorder visited each farm at intervals of 28 days.

Of the 740 cows and heifers tested by this society, 109 cows and 40 heifers were included in Class I., and 75 cows and 20 heifers in Class III. Thus, of the total cows and heifers tested, 20 per cent were placed in Class I. and 13 per cent in Class III., compared with 21 per cent and 11 per cent respectively in 1915.

Kirkcolm and District Milk Record Society.

This society was in its third year. The number of members was 15, the same number as in the previous year, and three of the members had very large herds, requiring two days' testing on each visit. The number of cows tested was 943, practically the same number as in 1915, and a large number for a society conducting 21 days' tests.

In practically all the dairying districts of Wigtownshire the bulk of the milk produced is made into cheese, and most of the cows calve in the early spring.

The records dated from the beginning of January and extended to 28th November, a period of 47 weeks, most of the cows being dry at this date.

Of the 943 cows and heifers tested by this society, 377 cows and 114 heifers were included in Class I., and 6 cows and 2 heifers in Class III. Of the total cows and heifers tested, excluding one herd not tested to the end of the season, 56 per cent were placed in Class I. and 1 per cent in Class III.; a substantial improvement of 21 per cent and 5 per cent respectively from 1915, and of 31 per cent and 10 per cent from 1914.

Kirkcolm and Leswalt Milk Record Society.

This society was instituted in 1908, and was in its ninth year, though systematic milk recording was commenced in practically the same district in 1906 by the Rhins of Galloway Dairy Association. The number of members of the society in 1916 was 18, one more than in the previous years. The number of cows tested was 1033, an increase of 86 from 1915, and a large number for a society conducting 21 days' tests.

The district is entirely a cheese-making one, and most of the cows calve in the early spring.

The records dated from 1st January, and covered the whole year with the exception of ten days at the end of December, when very few cows were in milk. The recorder visited each farm at intervals of 21 days.

Of the 1033 cows and heifers tested by this society, 340 cows and 100 heifers were included in Class I., and 30 cows and 2 heifer in Class III. Thus, of the total cows and heifers tested, 43 per cent were placed in Class I. and 3 per cent in Class III., compared with 56 per cent and 2 per cent respectively in 1915, and with 30 per cent and 8 per cent respectively in 1914.

Kirkmaiden and Stoneykirk Milk Record Society.

This society was in its fifth year. The number of members in 1916 was 18, the full membership of the society, and some of the herds were very large. An objection to the scheme of recording in former years by some of the members whose herds were exceptionally large was the necessity of accommodating the recorder for two days on each round. In order to meet such objection it was arranged that in the cases of very large herds, where desired, the recorder should merely weigh the milk, test the samples, enter the particulars in the byre sheets, and post the byre sheets to the superintendent's office, where the sheets would be completed and the record books entered up, the local society paying the cost of the clerical work according to the time required. Four of the members took advantage of this arrangement in 1916, and the charge made for the clerical work in the office, including postage, amounted to no more than 25s. per herd. Thus a considerable saving was effected, while the recorder was able to do all the work required by these large herds in one day on each round.

The recorder was called up for military service in March, and a young Danish recorder was appointed; but owing mainly to the difficulty of obtaining sufficient labour for such large dairies, five of the members made this the occasion to temporarily discontinue recording. The number of members who continued recording to the end of the year was 13. The total

number of cows tested was 1367, the largest number tested by one society in 1916.

The district is entirely a cheese-making one, and practically all the cows calve during the early spring months.

The records dated from the beginning of January and extended to 4th November, a period of 44 weeks, most of the cows being dry at this date. The recorder visited each farm at intervals of 21 days.

Of the 1367 cows and heifers tested by this society, 243 cows and 58 heifers were included in Class I., and 65 cows and 13 heifers in Class III. Of the total cows and heifers tested, excluding the five herds not tested to the end of the season, 33 per cent were placed in Class I. and 8 per cent in Class III., compared with 37 per cent and 3 per cent respectively in 1915, and with 19 per cent and 11 per cent respectively in 1914.

Lesmahagow Milk Record Society.

This society was inaugurated in 1907, and was in its tenth year. The number of members in 1916 was 23, the same number as in the three previous years. The number of cows tested was 625.

The district is chiefly a milk-selling one, and on most of the farms cows calve at all seasons, but in a few cases cheese is made, and the majority of the cows calve in the spring months.

Recording was continued during the whole year. The recorder visited each farm at intervals of 28 days.

Of the 625 cows and heifers tested by this society, 221 cows and 132 heifers were included in Class I., and 18 cows and 5 heifers in Class III. Thus, of the total cows and heifers tested, 56 per cent were placed in Class I. and 4 per cent in Class III., an improvement of 4 per cent and 2 per cent respectively from 1915.

Lower Wigtownshire Milk Record Society.

This society was in its tenth year. In 1913, in order to accommodate a number of new applicants, the district was divided and two branch societies formed, one in the Whithorn district and the other in the Newton Stewart district. In 1915 the Whithorn Society consisted of 13 members conducting 17 days' tests, and the Newton Stewart Society of 15 members conducting 19 days' tests. But as a few of the members desired not to take advantage of the recording for a year, it was agreed to amalgamate the two societies for 1916 and conduct 28 days' tests. The number of members in 1916 was 23. Two of the herds required two days' testing on each visit. The number of cows tested was 1230.

The district is almost entirely a cheese-making one, and most of the cows calve during the early spring months.

In former years recording in Lower Wigtownshire was discontinued each season for about a month at the end of the year when few cows were in milk; but in 1916, to meet the requirements of members with back-calving cows or heifers, recording was continued throughout the whole year. The recorder visited each farm at intervals of 28 days.

Of the 1230 cows and heifers tested by this society, 527 cows and 147 heifers were included in Class I., and 35 cows and 1 heifer in Class III. Thus, of the total cows and heifers tested, 55 per cent were placed in Class I. and 3 per cent in Class III.; an improvement of 12 per cent and 1 per cent respectively compared with the average results of the two Lower Wigtownshire Societies in 1915.

Mauchline Milk Record Society.

This society was in its sixth year. The number of members was 18, an increase of one member from the previous year, and one more than the full membership for a society conducting 20 days' tests. The number of cows tested was 618, practically the same number as in 1915.

Most of the members of this society make cheese during the summer months, and sell milk during late autumn, winter, and early spring. On some of the farms milk is sold during the whole year. Most of the cows calve in spring, but a certain proportion calve in autumn or winter.

Recording was continued during the whole year. The recorder visited each farm at intervals of 20 days.

Of the 618 cows and heifers tested by this society, 337 cows and 119 heifers were included in Class I., and 12 cows and 2 heifers in Class III. Thus, of the total cows and heifers tested, 74 per cent were placed in Class I. and 2 per cent in Class III.; an improvement of 4 per cent and 1 per cent respectively from 1915.

Monkton and District Milk Record Society.

This society was in its fourth year. The society was formerly known as "The Central Ayrshire No. 3 Milk Record Society," but at the beginning of 1915 the members decided to change the name of the society so as to give a clearer indication of the locality in which the society operated. The members were situated chiefly in the Monkton, Tarbolton, Symington, and Craigie districts. The number of members in 1916 was 19, an increase of six from the previous year, and one more than the full membership of the society. The number of cows tested was 820, an increase of 222 from the previous year.

On some of the farms in this district milk is sold all the year round, and on other farms cheese is made during the greater part of the summer. Cows calve at all seasons, but the greater proportion calve in spring.

Recording was continued during the whole year. The recorder visited each farm at intervals of 21 days.

Of the 820 cows and heifers tested by this society, 289 cows and 95 heifers were included in Class I., and 59 cows and 11 heifers in Class III. Thus, of the total cows and heifers tested, 47 per cent were placed in Class I. and 8 per cent in Class III.; an improvement of 10 per cent and 6 per cent respectively from 1915.

Montgomerie Milk Record Society.

(Irvine and Dundonald Districts.)

This society was in its sixth year. The members were situated chiefly in the Irvine, Dundonald, and Crosshouse districts of Ayrshire. The number of members in 1916 was 23, a decrease of two from the previous year. The number of cows tested was 751, a decrease of 106 from the previous year.

Most of the members of this society sell milk all the year round; their cows calve at all periods of the year.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 28 days.

Of the 751 cows and heifers tested by this society, 417 cows and 129 heifers were included in Class I., and 6 cows and 1 heifer in Class III. Thus, of the total cows and heifers tested, 73 per cent were placed in Class I. and less than 1 per cent in Class III.; an improvement of 5 per cent and 2 per cent respectively from 1915, and of 13 per cent and 2 per cent respectively from 1914.

Nithsdale Milk Record Society.

The members of this society were situated chiefly in the Sanquhar and Thornhill districts of Dumfriesshire. It is one of the oldest milk record societies in Scotland. The Nithsdale dairy farmers commenced milk recording in 1903, the year of the introduction of systematic milk recording into Scotland, but ceased recording for the next two years. The present society was formed in 1906, and in 1916 was in its eleventh year. The number of members in 1916 was 22, a decrease of one from the previous year. The number of cows tested was 910.

Most of the members of this society make cheese during the summer months, and some of the farmers send milk to town in autumn and winter. The majority of the cows calve in the spring months.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 27 days.

Of the 910 cows and heifers tested by this society, 359 cows and 102 heifers were included in Class I., and 56 cows and 8 heifers in Class III. Thus, of the total cows and heifers tested, 50 per cent were placed in Class I. and 7 per cent in Class III., compared with 55 per cent and 4 per cent respectively in 1915, and with 50 per cent and 8 per cent respectively in 1914. It should be pointed out that in this case the apparent retrogression in 1916 was due largely to the introduction of new members.

The North of Scotland Milk Record Society.

This society was in its second year. The members were very widely scattered from Arbroath to Inverness, in the different counties of Forfar, Kincardine, Aberdeen, and Inverness, and the recorder had to travel by rail over 380 miles on each circuit. The number of members in 1916 was 9, an increase of 4 from the previous year, the majority being breeders of British Holstein-Friesian cows. The number of cows tested was 369, an increase of 163 from 1915.

All the members of this society produce milk for direct sale, and their cows calve at all seasons.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 28 days.

Of the 369 cows and heifers tested by this society, 115 cows and 15 heifers were included in Class I., and 18 cows but no heifers in Class III. Thus, of the total cows and heifers tested, excluding 1 herd not tested to the end of the recording season, 39 per cent were placed in Class I. and 5 per cent in Class III.; a substantial improvement of 28 per cent and 4 per cent respectively from 1915.

Ochiltree Milk Record Society.

This society was in its fifth year. The number of members in 1916 was 17, the full membership of the society, though one less than in the previous year. The number of cows tested was 482, practically the same number as in the previous year.

Most of the members in this district make cheese during the summer, and on some farms milk is sold in autumn and winter. The greater proportion of the cows calve in spring.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 20 days.

Of the 482 cows and heifers tested by this society, 226 cows and 96 heifers were included in Class I., and 8 cows and 3 heifers in Class III. Thus, of the total cows and heifers

tested, 67 per cent were placed in Class I. and 2 per cent in Class III., compared with 70 per cent and 1 per cent respectively in 1915.

Renfrewshire (Upper Ward) Milk Record Society.

This society was in its sixth year. The number of members in 1916 was 15, one less than in the previous year. The number of cows tested was 597.

The members of this society produce milk for direct sale, and their cows calve at all seasons.

Recording was continued during the whole year. The recorder visited each farm at intervals of 20 days.

Of the 597 cows and heifers tested by this society, 190 cows and 68 heifers were included in Class I., and 26 cows and 8 heifers in Class III. Thus, of the total cows and heifers tested, 43 per cent were placed in Class I. and 6 per cent in Class III., exactly the same percentages as in 1915.

Stewarton and Dunlop Milk Record Society.

This society was in its third year. The members were situated throughout the wide and important dairying districts of Lugton, Dunlop, Stewarton, Kilwinning, Beith, Montgreenan, and Kilmaurs. The number of members in 1916 was 26, an increase of 3 members from the previous year, and 2 more than the full membership of the society. The number of cows tested was 972, an increase of 86 from 1915.

In the districts of this society all the usual systems of dairying are carried on. On most of the farms milk is sold all the year round; on some butter is made; and on others the surplus milk is made into cheese during the summer months. Cows calve at all periods of the year.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 28 days.

Of the 972 cows and heifers tested by this society, 387 cows and 98 heifers were included in Class I., and 46 cows and 12 heifers in Class III. Thus, of the total cows and heifers tested, 50 per cent were placed in Class I. and 6 per cent in Class III.; an improvement of 7 per cent and 2 per cent respectively from 1915; and of 12 per cent and 2 per cent respectively from 1914.

The Stewartry Milk Record Society.

As in former years, the whole of the milk recording in the Stewartry of Kirkcudbright was carried on under the direction of one County Milk Record Society. This system offers several

advantages. All overlapping of circuits is avoided. There is no difficulty in accommodating all new applicants at the beginning of each year, no matter from which districts the applications come. Where an ordinary local society at the end of the year falls temporarily short of full membership the existence of the society is threatened, owing to the expense becoming proportionately greater for the remaining members; but in the case of a county society employing more than one recorder, new members at a considerable distance, or even at the other end of the county, may take the places of retiring members, and all members pay on the same basis.

The Stewartry Milk Record Society was formed in 1906, and in 1916 the society was in its eleventh year. The total number of members was 43, a decrease of 17 from the previous year. The total number of cows tested was 2513, compared with 3437 in 1915.

In 1915 the Stewartry Society required three recorders, but in 1916 only two recorders were employed.

Circuit No. 1.

(New Abbey, Kirkbean, Dalbeattie, and Castle-Douglas Districts.)

The number of members on this circuit was 20. They were situated in the eastern portion of the county, mainly in the New Abbey, Kirkbean, Dalbeattie, and Castle-Douglas districts. The number of cows tested was 1130.

Most of the dairy farms in the Stewartry are cheese-making farms, and practically all the cows calve in the early spring months.

Recording was continued throughout the whole year. The recorder visited each farm at intervals of 24 days.

Of the 1130 cows and heifers tested on this circuit, 406 cows and 190 heifers were included in Class I., and 54 cows and 13 heifers in Class III. Thus, of the total cows and heifers tested, 53 per cent were placed in Class I. and 6 per cent in Class III.; an improvement of 9 per cent and 1 per cent respectively, compared with the average results of Circuits 1 and 2 in 1915, and an improvement of 29 per cent and 6 per cent respectively from 1914.

Circuit No. 2.

(Castle-Douglas and Kirkcudbright Districts.)

The number of members on this circuit was 23. The members were situated chiefly in the Kirkcudbright district and towards Castle-Douglas. The number of cows tested was 1383.

The district is almost entirely a cheese-making one, and practically all the cows calve in the early spring.

Recording was carried on throughout the whole year. The recorder visited each farm at intervals of 28 days.

Of the 1383 cows and heifers tested on this circuit, 370 cows and 185 heifers were included in Class I., and 98 cows and 13 heifers in Class III. Thus, of the total cows and heifers tested, 40 per cent were placed in Class I. and 8 per cent in Class III.; an improvement of 2 per cent and 1 per cent respectively, compared with the average results of Circuits 2 and 3 in 1915, and of 13 per cent and 6 per cent respectively from 1914.

General Review.

It was inevitable that Milk Recording in 1916 should be to a large extent influenced by the war. The number of cows tested was reduced from 26,572 in 1915 to 22,702 in 1916. This is the first reduction in the number of cows tested annually under the scheme of the Association since 1904, the year after the inauguration of systematic milk recording in Scotland; and it is safe to assume that but for the war the number of cows tested in 1916 would have been higher than in any previous year. And when all the circumstances are considered, it is a matter for congratulation that the reduction in number was not greater.

During 1915 the difficulties in milk production tended to increase rather than diminish, and for various reasons a number of dairy farmers decided to give up recording at the end of the year. Special difficulties which dairy farmers had to contend with were scarcity of labour and costs of concentrated cattle foods and artificial manures. A number of former members decided to dispose of their entire herds. A number of local societies were obliged to consider whether milk recording could be continued in 1916 or during the period of the war. Several societies agreed to leave the matter to the decision of the Executive Committee.

The matter was discussed at a meeting of the Executive Committee, and the Committee were unanimously of opinion that the circumstances did not warrant suspension of milk recording. Attention was drawn to the report of the Scottish Departmental Committee on Food Production, and to the efforts of the Board of Agriculture for Scotland to impress upon farmers the necessity of increasing home production in 1916. It was pointed out that through the efforts of the Association milk production in Scotland had already been considerably increased, and that it was undesirable that local societies should suspend or relax their efforts in that direction.

The difficulties in 1916 merely served to show to what

degree milk recording was already considered indispensable in Scotland, and how many farmers fully realised the importance of the work.

Milk recording was continued by twenty-eight local societies comprising 533 members, and the results obtained more than justified their enterprise. More than this number of dairy farmers desired to continue recording, but a considerable number were compelled to discontinue by the decisions of small majorities. In a number of cases some of the members of a society which discontinued were included in neighbouring societies; but in other cases such an arrangement was not possible, owing to the large distances separating the applicants from the nearest recording district. But most of the members who discontinued recording did so with the intention of resuming after the war.

No new societies were formed in 1916, but a certain number of new members were obtained throughout the various districts and accommodated in existing societies. It was evident also that many other dairy farmers were interested in the subject, and intended to commence recording as soon as conditions again became normal.

During the year thirty-one recorders or members of the central staff, including the interim assistant superintendent and also his successor, left to join the Army or for other reasons, and by the end of the year not a single recorder remained who was eligible for military service. The removal of so many experienced recorders could hardly fail to have a considerable influence on the recording. Of the factors affecting the progress of milk recording the individuality of the recorder is one of the most important. An inefficient, careless, or unpopular recorder renders recording unpopular among dairy farmers; while, on the other hand, a conscientious and popular recorder has great influence in stimulating interest in milk recording in the district and increasing the membership.

The Committee, however, were able to recommend a sufficient number of qualified women-recorders, and also a small number of young men-recorders ineligible for military service. Unfortunately a number of local societies at first held rather conservative views with regard to the employment of women-recorders, and in such cases there was considerable difficulty in obtaining suitable recorders from among the small number of young lads available. Few of the young men applicants under military age proved to be reliable recorders; in most cases they failed to carry out the duties faithfully and conscientiously. In the case of societies who agreed to employ women-recorders, a better selection was possible, and little or no difficulty was experienced. Qualified women-recorders of the proper type were found to be quite capable of success-

fully carrying out all the duties connected with milk recording; and a number of societies who formerly were opposed to the employment of women-recorders subsequently appointed a woman-recorder. Twenty women-recorders were employed in 1916, and a number of these recorders were found to be exceedingly popular with the members, and to be most reliable recorders.

Owing to shortage of labour on farms, the conveying of the recorder and the apparatus from one farm to another was a more serious item than formerly. A number of members who had longer distances to travel felt compelled to give up recording for this reason alone. A solution of this difficulty has been found in local societies owning a small pony and trap for the purpose. Several societies who formerly did not own a turnout procured one during the year.

Previous to the war all the Gerber milk-testing apparatus used by local societies was manufactured in Germany or Austria; and in 1915 the Committee experienced difficulty in procuring the necessary supplies, but were ultimately able to purchase forward supplies by new makers at increased prices. In 1916 less difficulty was experienced in this respect, but the higher prices for apparatus continued.

In May 1915 the Government requisitioned the larger part of the output of sulphuric acid in this country, and the firm supplying the Association had difficulty in meeting the Association's requirements. In 1916, with the exception of the month of August, no great inconvenience was caused by delay in delivery of acid. The Government produced a larger proportion of their sulphuric acid requirements by means of their own plant. The price paid in 1916 was the same as in 1915—namely, 10s. per cwt. The strong two-compartment cases and rubber-stoppered jars specially designed for the conveyance of sulphuric acid by rail, and first used in 1915, were employed during the year, and were found of great service in facilitating delivery of acid to the various districts.

With regard to the supply of amylic alcohol, the cheaper quality, used for the first time in 1915, was continued in use in 1916 with satisfactory results; and adequate supplies were obtainable at the very moderate price of 1s. 5d. per lb., compared with the former price of 2s. 6d.

On account of the unfavourable conditions prevailing in 1916, many anticipated that milk yields would be below the average. The very large herds suffered more in this respect than the smaller herds. The weather generally in 1916 was also unfavourable, as evidenced by the diminution of farm produce in Scotland as a whole, and the untoward season no doubt reacted to some extent on the milk records. Thus we

find that the better herds were hardly able to maintain their high standard of 1915.

Under the circumstances it would not have been surprising had a considerable drop in the milk records generally occurred, and *it is all the more gratifying to find on the contrary a substantial general improvement.*

The following table shows for each society the number and percentage of cows and heifers of each class:—

Society.	Cows and Heifers.				
	Number.			Percentage.	
	Total.	Class I.	Class III.	Class I.	Class III.
1. Annandale	950	673	21	71	2
2. Ayr and Stair	725	421	39	58	5
3. Carrick	584	235	37	47[1]	7[1]
4. Central Ayrshire No. 1	635	363	32	57	5
5. Coylton and District	501	412	10	82	2
6. Cumnock	654	468	8	72	1
7. Dumbartonshire	570	325	25	57	4
8. Dumfries and District	673	270	60	40	9
9. Dunragit	1064	650	7	61	1
10. Fenwick (High)	954	567	26	59	3
11. Fife	706	456	26	65	4
12. "John Speir"	718	263	25	44[1]	4[1]
13. Kintyre and Islay	740	149	95	20	13
14. Kirkcolm and District	943	491	8	56[1]	1[1]
15. Kirkcolm and Leswalt	1033	440	32	43	3
16. Kirkmaiden and Stoneykirk	1367	301	78	33[1]	8[1]
17. Lesmahagow	625	353	23	56	4
18. Lower Wigtownshire	1230	674	36	55	3
19. Mauchline	618	456	14	74	2
20. Monkton and District	818	377	70	46	8
21. Montgomerie	751	546	7	73	1
22. Nithsdale	910	461	64	50	7
23. North of Scotland	369	130	18	39[1]	5[1]
24. Ochiltree	482	322	11	67	2
25. Renfrewshire (Upper Ward)	597	258	34	43	6
26. Stewarton and Dunlop	972	485	58	50	6
27. Stewartry No. 1	1130	596	67	53	6
28. Stewartry No. 2	1383	555	111	40	8
Of all the cows and heifers tested in 1916	22,702	11,697	1043	53¼[1]	4¾[1]
Comparison with 1915	26,572	12,313	1561	46	6
Comparison with 1914	26,424	10,439	2307	39½	9

[1] Excluding herds not tested to the end of the recording season: 14 herds (762 cows) in all.

Reviewing the results of the twenty-eight societies as a whole, we find that of 22,702 cows and heifers tested in 1916, 11,697 or 53¼ per cent were included in Class I., and only 1043 or 4¾ per cent in Class III.

Thus, 53¼ per cent of all the cows and heifers tested gave a milk yield equivalent to not less than 714 gallons containing 3·5 per cent milk fat in the case of a cow, and 571 gallons in the case of a heifer; while less than 5 per cent gave a milk yield equivalent to less than 474 gallons containing 3·5 per cent milk fat in the case of a cow, and 380 gallons in the case of a heifer. In 1915 only 46 per cent were eligible for Class I., and 6 per cent were included in Class III. So that the records of 1916 compared with the records of the previous year show a general improvement of 7¼ per cent in Class I. and of 1¼ per cent in Class III.

A perusal of the brief reports on the work of individual societies shows a highly consistent improvement throughout. In a few cases a relatively great advance in 1915 was followed in 1916 by a certain falling off, but in such cases when comparison is made with 1914 it is found that a decided improvement has been maintained.

Considering the disadvantageous conditions for milk production in 1916 already referred to, and the unfavourable weather during the season, it is evident that the improvement in the herds tested under the Association's scheme must be attributed mainly to improvement in the inherent milking qualities of the animals by selection and breeding on milk record lines. Thus, further evidence has been obtained that the objects of the Association are being steadily attained year by year.

The Association's method of comparing milk yields and of estimating progress in this respect is by ascertaining the percentage of animals included annually in Classes I. and III. respectively, as defined on page 190. This is a convenient method of comparison. Further, it is probably a sound policy to encourage the formation of herds composed entirely of good-milking animals, and containing no unprofitable cows, rather than herds containing a number of cows giving abnormally high yields which cannot be maintained without risk of deterioration of the animals and of their progeny.

Yet it is important to know what a given increase in the percentage of Class I. cows means when translated into actual milk yield. It is obvious that a natural improvement in the percentage of Class I. cows, in a total of approximately 26,000 cows, of from 39½ per cent to 53¼ per cent in two years, represents a large and rapid increase in milk yield. The actual figures could be obtained only by laborious calculations. But it is possible to obtain a sufficiently approximate estimate for

all practical purposes by dealing with the results of a small number of typical herds. We give below the results of a brief investigation of the records of 10 herds, comprising herds well above the average, approximately average herds, and herds below the average:—

Herd.		Number of Cows tested in 1916.	Percentage in Class I. in 1911.	Percentage in Class I. in 1916.	Improvement in percentage in Class I. in 5 years.	Average milk yield in gallons at 1 per cent in 1911.	Average milk yield in gallons at 1 per cent in 1916.	Per cent improvement in average milk yield in 5 years.
Society.	Farm Letter in 1915.							
Ochiltree	R	20	69	100	31	2716	3365	24
Carrick	O	43	62	95	33	2658	3314	25
Stewartry II.	U	77	42	82	40	2327	2918	25
Mauchline	M	54	40	80	40	2351	2959	26
Carrick	E	42	15	55	40	2000	2458	23
Dunragit	A	64	5	53	48	1771	2455	39
Newton Stewart	L	34	11	53	42	1862	2413	30
Whithorn	I	79	26	51	25	2229	2668	20
Whithorn	O	67	10	49	39	1961	2384	22
Stewartry I.	L	55	6	46	40	1783	2366	33
Average of 10 Herds					37·8			26·7
Average of 5 years					7.56			5·34

From the above table we find that the percentage improvement in milk yield in five years has been remarkably similar in poor, average, and good-milking herds alike, the average rate of improvement being approximately 5·34 per cent per annum.

But our main object at present is to ascertain whether there is any approximately constant ratio between the percentage improvement in the number of Class I. cows and the percentage improvement in average milk yield. Here, again, we find that the ratio is remarkably constant in poor, average, and good-milking herds, the average ratio being 37·8 to 26·7, or approximately 1·42 to 1. This ratio would seem to be a good working factor on which to base a calculation of total improvement in milk yield of all cows tested. The improvement in the number of Class I. cows in 1916 compared with 1915 was $7\frac{1}{4}$ per cent, and in 1915 compared with 1914 was $6\frac{1}{2}$ per cent. Therefore, according to the ratio obtained, the percentage increase in milk yield in 1916 was $\frac{7·25}{1·42}$, or approximately 5·1 per cent, or a little over 5 per cent per annum, and the percentage increase in 1915 was $\frac{6·50}{1·42}$, or approximately 4·58 per cent per annum. These are results which we believe will be readily accepted as moderate

estimates by those who have practical acquaintance with dairy herds in which milk recording has been conducted.

The total increase in milk yield in 1916 of the 22,702 cows and heifers tested, calculated at the rate of 5 per cent per annum, amounts to not less than 770,746 gallons of milk of 3·5 per cent fat. But increase in milk yield which is due to improvement in the inherent milking qualities of the cows is *a cumulative increase.* So that the total increase in milk yield of all the cows tested during the 14 years (1903-1916 inclusive) in which milk recording has been carried on in Scotland must represent a very large volume of milk. Taking only the last five years, the period during which a grant has been given annually from the Development Fund, and estimating on the moderate basis of a percentage increase in milk yield of 4·75 per cent per annum, we get the following result:—

Year.	Number of Cows tested.	Estimated total increase in milk yield in gallons at 3·5 per cent fat compared with the previous year.	Estimated total increase in milk yield in gallons at 3·5 per cent fat compared with 1911.
1912	18,356	488,269	488,269
1913	22,816	637,251	1,125,520
1914	26,424	774,421	1,899,941
1915	26,572	817,886	2,717,827
1916	22,702	732,209	3,450,036
Total increase in five years .			9,681,593

Sceptical critics are fond of insinuating that the milk records of the Association may not be reliable. The records are merely estimates of the actual milk yields; but that the estimated yields approximate closely to the actual yields in nearly all cases has been definitely established.

But we are not at present dealing specially with the total quantity of milk recorded, but more particularly with *the improvement* in the milk records when compared with similar records of previous years made under similar conditions; and the improvement in the records is an accomplished fact. To account for such improvement satisfactorily, apart from actual improvement in milk yield, critics would require to show that the improvement has been merely in the art of deception. Yet though the Association's rules with regard to recording have

been made more stringent from time to time, and supervision has been increased, the rate of improvement as shown by the records has been fully maintained.

In the above estimates of improvement in milk yields, no account has been taken of improvement in herds outside of those tested, due to the use of milk record sires. Yet the better-known herds tested under the Association's scheme have disseminated annually a large number of young bulls off heavy-milking dams. It is gratifying to see the keener demand for such bulls, and the higher prices offered for them as the value of milk recording becomes more and more widely recognised.

The Executive Committee have decided on a forward step in 1917 which should prove a distinct stimulus in this direction. The Committee have decided to publish in their Annual Report a register of good-milking cows, giving full particulars of the milk records, and the names and addresses of the owners. At present many owners of herds on the outlook for young bulls from proved good-milking dams have difficulty in knowing where to apply. In future, the special register in the Association's Annual Report should meet this felt want, and ought therefore to have a distinct influence in accelerating the rate of progress in milk production in Scotland.

ANALYSES FOR MEMBERS DURING 1916.

By Dr J. F. TOCHER, Aberdeen, Analyst to the Society.

THE number of samples submitted for analyses during the year 1916 was 144. The following table shows the numbers and nature of the samples analysed during the last six years:—

	1916.	1915.	1914.	1913.	1912.	1911.
Fertilisers	47	36	48	46	58	68
Feeding-stuffs	34	28	28	25	28	23
Waters	22	26	44	27	15	17
Miscellaneous	41	51	22	19	21	18
	144	141	142	117	122	126

FERTILISERS.

General.—Samples of all the well-known varieties of fertilisers were submitted for analysis, slags and special mixtures being predominant. The typical potato manure for 1916 was one represented by the following values—namely, soluble phosphate, 14·8 per cent; insoluble phosphate, 9·2; nitrogen, 6·5; and potash, 2·4 per cent. The proportion of potash was only about 1 per cent lower than the proportions usually found to be present in pre-war times. The proportion of nitrogen in potato manures was distinctly higher this season than it was during the previous three seasons. Contrary to previous experience, the samples of slag submitted for analysis showed great variation in composition. Two contained less than 3 per cent of citric soluble phosphate, one contained 6 per cent, two contained 26·5 per cent, one contained 31·4 per cent, and one 34·3 per cent. One sample was found to be deficient in total phosphates to the extent of 2½ per cent, and in citric soluble phosphate to the extent of 12½ per cent. So large a deficiency as 12½ per cent in citric soluble phosphate deserves special notice, as usually basic slags are well up to the guarantee both in citric soluble phosphate and in total phosphate. Slags possessing a low citric solubility were found to contain less than 16 per cent total phosphate. Where the prices were higher than the current market value when the phosphate content was considered, the terms were adjusted between the buyer and seller on the basis of the current price at the date of sale. A sample of whalebone meal was found to contain 4·4 per cent

of nitrogen and 47 per cent of insoluble phosphate. A sample of guano was analysed showing the high content of both nitrogen and potash, and is mentioned as showing one of the many sources of the supply of potash for fertilising purposes.

Diatomaceous Peat.—Several samples of diatomaceous peat were examined. It was found that these samples were not sufficiently pure to be useful for mixing with explosives, but the peat would be very useful as an absorbent of antiseptic liquids. The following table gives the results of analysis of the four samples of diatomaceous peat:—

	Moisture.	Silica.	Nitrogen.	Lime.	Potash.
1.	79·85	8·91	0·38	0·20	0·16
2.	14·33	52·76	1·21	0·40	0·26
3.	58·92	37·38	0·03	0·44	0·26
4.	2·38	86·51	0·03	0·46	0·83

Feeding Stuffs.

General.—There was a greater variety than usual of feeding-stuffs analysed during 1916. These included bean middlings, cooked maize, dried dreg, wheat germs, millers' offals, bean-meals, oatmeals, Indian meals, besides the usual earth-nut, linseed, cotton-seed, and mixed cakes. Two of the samples of oatmeal were distinctly below the quality for ordinary Scots oats.

Bean-Meal.—Several samples of bean-meal were found to be adulterated with oat husks and other foreign matter. The average composition of bean-meal from beans belonging to the species *Vicia,* the "broad" or "field" bean, was found to be as follows: 1·9 per cent of oil, 28·1 albuminoids, and 46·8 per cent carbohydrates. Meal made from haricot beans was found to contain 1·6 per cent of oil, 20·3 per cent albuminoids, and 56·5 per cent carbohydrates. These figures represent the average composition of what is ordinarily understood as bean-meal. Of the adulterated samples one was found to contain as much as 6·3 per cent of oil, 19·8 per cent of albuminoids, and 50·4 carbohydrates. The adulterant in this case was oat husks. Another sample was found to contain 10 per cent of oil and 24 per cent of albuminoids, and was also found to contain "soya" beans as well as "broad" bean. The adulterated samples could not be said to be injurious to stock, but they were

sold to the prejudice of the purchaser in being characterised as "bean-meal" instead of, say, "bean mixture." In certain cases the price of the bean-meal was less than the current price of beans at the time of purchase.

The problem of determining whether or not it is possible under the Fertilisers and Feeding Stuffs Act, 1906, to require from manufacturers a statement naming the particular genus, species, or variety of bean-meal, or of standardising, as it is called, bean-meal, is by no means a simple one. It would be well to recall the words of the section of the Act bearing on the problem. The following is the section referred to:—

"Every person who sells for use as food for cattle or poultry any article which has been artificially prepared shall give to the purchaser an invoice stating the name of the article, and whether it has been prepared from one substance or seed, and in the case of any article artificially prepared otherwise than by being mixed, broken, ground or chopped, what are the respective percentages (if any) of oil and albuminoids contained in the article, and the invoice shall have effect as a warranty by the seller as to the facts so stated, except that as respects percentages the invoice shall have effect as a warranty only that the actual percentages do not differ from those stated in the invoice beyond the prescribed limits of error."

It will be seen from this section that the seller must give to the purchaser an invoice stating

(1) the name of the article;

(2) whether it is prepared from one substance or seed; and

(3) the percentages of oil and albuminoids contained in the article of food artificially prepared (as above defined).

The following list is a selection of the names of articles implying that the food is prepared from one substance or seed—linseed-cake, ground-nut cake, cotton-seed cake, decorticated cotton-cake, undecorticated cotton-cake (Egyptian), undecorticated cotton-cake (Bombay), palm-nut kernal cake, maize-meal, rice-meal, and oatmeal. The following descriptions are usually given of foods prepared from more than one substance or seed: oilcake, seed-cake, fattening cake, mixed cake, compound cake. No indication or statement is usually made to the purchaser what these compound or mixed cakes are composed of. Often trade names are given for mixed cakes. Three descriptions exist which may bear more than one interpretation, and therefore are of an ambiguous character—pea-meal, bean-meal, nutmeal. It is quite open to any seller of bean-meal to supply bean-meal prepared from soya bean, locust bean, all the species and varieties of broad bean, all the species and varieties of kidney bean, and several other genera and species of plants which yield pods or legumes. It is quite true that soya bean

is not usually sold as bean-meal. It is usually described as soya-bean meal. But soya bean has been found present in bean-meal made mainly from broad bean. It is also the case that locust-bean meal is not usually put on the market as bean-meal. It is offered as locust-bean meal.

So far as chemical composition is concerned, peas and beans fall into four distinct groups and classes—namely, (1) the various genera and species of broad beans (of various home and foreign origins), of which the "broad" bean and "kidney" bean are the types, possessing not more than 2½ per cent of oil, and albuminoids varying from 20 to 28 per cent; (2) the group of peas (English and foreign) never possessing more than 2¼ per cent of oil, and albuminoids ranging from 22 to 32 per cent; (3) the group of soya beans from various foreign sources having about 17 to 19 per cent of oil, and 32 to 38 per cent of albuminoids; and (4) the species of locust beans (*Ceratonia siliqua*) containing 1 per cent of oil, 5 per cent of albuminoids, and 70 per cent of digestible carbohydrates.

Judging from the great differences in the percentages of the constituents of the foods in each of the four classes, it is clear that sellers should be required, on this ground alone, to state to which of the four classes the manufactured article belongs. They are foods with distinctly different proportions of oil and albuminoids, and with different names, each of them habitually used by both buyers and sellers, to describe the respective classes, and the names are not interchangeable. One cannot supply locust-bean meal for soya-bean meal, although it would appear from the wording of the section that all the four could be supplied as bean-meal *if* "bean-meal" is properly used as a name of an article prepared from one substance or seed. The problem now is: Is bean-meal really a proper term stating the name of the article prepared from one substance or seed, as required by section (2)? It is clear that the use of the term "bean-meal," as describing an article made from one substance or seed, is not a compliance with the provisions of section (2), although by use and wont "bean-meal" is understood to mean meal made from a species of broad bean or a species of kidney bean. As has been shown, it can be used, and has been used, to describe soya-bean meal and locust-bean meal, as well as to describe meal made from various species of beans and peas. Whether or not sellers should be further required to state the genus and species, and also origin of the seed or substance from which the meal is made, in order that the article may be properly named, depends (1) upon whether section (2) of the Act legally compels them to give these particulars; and (2) whether it is possible that the analyst can detect, for example, the presence or proportion of, say, meal made from "field" or "broad" bean, and the pro-

portion from "kidney" or "haricot" bean in a mixture of these two genera. From microscopical examinations of all the genera and species, the analyst could say whether the meal was a mixture of "broad" beans and "kidney" beans, from whatever source the "broad" bean or "kidney" bean was drawn. It is doubtful whether one could state accurately the proportions of "broad" bean and "kidney" bean in a mixture, but one might be able to state the proportions roughly from a microscopical examination. Indeed, one must go further than this. No analyst can do anything further than estimate from the known average composition of, say, oatmeal and "broad" bean-meal, and from his quantitative chemical results and qualitative microscopical examinations, what are the *likely* proportions of oats and "broad" beans in a mixed meal composed of "broad" beans and oats. The point now is: Is an official agricultural analyst required to state the proportions of, say, oats and "broad" beans in a meal sold as from a single substance or seed, but found to contain both oats and "broad" beans? Is he required to state the proportions of, say, "broad" beans and "kidney" beans in a meal sold as from a single substance or seed, but found from a microscopical examination to contain both "broad" beans and "kidney" beans? It is clear that an analyst is *not* required to state the proportions, for two very excellent reasons, namely:—

(1) Section 2 does not make any such provision; the meal is either from a single substance or from two or more substances.

(2) The analyst cannot be required to state more than he is able to state from his scientific knowledge.

The percentage composition of the constituents of "broad" beans and "kidney" beans, for instance, is very similar, and an analyst could not definitely state from chemical composition whether the meal was from one genus or the other. He could tell from a microscopical examination which genus the meal was derived from. That is all, and it is sufficient for the purpose of the Act. Sellers of bean-meal should be compelled to state more specifically than they have hitherto done the name of the article. The term "bean-meal" is not really a proper term stating the name of an article prepared from one substance or seed, as required by section (2) of the Fertilisers and Feeding Stuffs Act, 1906. Dairy farmers and agriculturists generally would have no complaint to make if a meal made from one substance or seed took its name from that substance. If, for example, the meal was made from "broad" or "field" beans, and the term "broad-bean meal" or the term "field-bean meal" were used, and its origin stated, there would be no difficulty on the part of the farmer in understanding what was offered for

sale. Mixtures of different species of beans should be sold as such, and in every such case farmers should demand from the seller a statement as to the proportions of oil and albuminoids guaranteed to be present in the mixture or in the meal stated to be made from two or more substances or seeds.

Ground-Nut Cake.—It sometimes happens that a sample of a fertiliser or a feeding-stuff may be quite up to the guarantee in the constituents named, but the material may not be value for the money paid. This arises mainly from the manner of sampling. A ground-nut cake was examined which was quite normal in composition, but which was found to be otherwise abnormal on account of the fact that occasional pieces of the cake contained pebbles of considerable size. For any one examination of this kind it is necessary to send not a small sample of ordinary size, but several complete pieces of the cake drawn from the consignment at random. It is very much to be regretted that the reputation of so excellent and rich a food as ground-nut cake should be endangered by such abnormal conditions. Another sample of cake was examined bacteriologically, because it was suspected of containing pathogenic organisms extremely dangerous to the life of farm stock. A small sample of less than half a pound was sent in this case. In a case of this kind a large mixed sample should be examined, and samples of other substances ought also to be sent for examination, as the problem cannot be settled by a negative result from one sample of one suspected feeding-stuff. All likely material should be examined. It is open to any one to have such samples examined by the local authorities, and also by the experts employed by the Board of Agriculture.

Miscellaneous Samples.

Woolball in Lambs.—Among the miscellaneous samples submitted to analysis were several carcases of young Cheviot lambs which were reported as having died of scour. These lambs were about a week old. No mineral or vegetable poisons were detected in the alimentary canals of these animals, but their stomachs contained more or less wool; while portions of the bowel wall, which was in a highly inflamed condition, were found to contain organisms associated with gastro-enteritis. Quite probably this is a case of infection from the soil, and, as a preventive measure, the setting apart of a grass field for the lambing of ewes has been recommended. I advised that the field should be thoroughly limed at the fall of the year, and that the ewes should be kept in this special grass field for at least a month after lambing. At the end of this period the

lambs would have developed more resistive power to infection, and since time would have been allowed for grass to grow longer, there would be less chance of picking up fragments of soil.

Medicinal Plants.—Several samples of medicinal plants were examined during the year. These were sent in for the purpose of having the proportions of active constituents determined and of obtaining advice as to their suitability for cultivation. Two of the samples were seeds from two varieties of meadow saffron, and were found to contain proportions of active constituents considerably above the average. Colchicum or meadow saffron contains, both in the subterranean stem and in the seed, a valuable active principle which is used in medicine for the relief of pain in gouty affections. Meadow saffron, as the name implies, grows in moist meadows. It is common in some parts of England, and, when common, the seeds and stem are worth collecting; but the general cultivation of meadow saffron is impracticable for many reasons. Foxglove or digitalis is a well-known plant, the leaves of which are collected during the second year of growth, just as the plants are commencing to flower. The proportions of the active constituents are very variable in the wild plant, and drug farms exist where foxglove is cultivated in order, by selection, to secure a variety of plant more constant in yield of physiologically determined active constituents. The growing of medicinal plants is a special branch of farming which requires considerable skill and knowledge of plant life, and is not to be recommended in the absence of special facilities and a suitable training.

Waters.—A large number of samples of waters were examined during the past year. One of the most difficult problems for an analyst to solve is to determine in certain cases whether a farm water supply, which has been found of doubtful quality or bad for human consumption, is injurious or dangerous to the health of live stock. It may, however, be stated quite definitely that no stream or farm supply which has been found to be distinctly polluted with sewage, as indicated by bacteriological tests, should be used for cattle or horses. The standard of quality should be almost, if not quite, the same standard as that employed in the case of man.

MILKING MACHINES.

REPORT ON AN INVESTIGATION BY THE SOCIETY REGARDING THE USE OF MILKING MACHINES IN SCOTLAND.

By WILLIAM BURKITT, B.Sc., F.H.A.S., N.D.D.

In commencing a report on this subject, it would be well to consider a brief history of milking by machinery.

As early as 1819 Americans tried to replace hand-milking by other methods, and in this country attention had been given to this matter, but it was not until 1840 or thereabouts that much was done, the first step being the use of milk syphons or milk tubes, which were soon discarded.

The next method adopted was that of mechanical pressure on the teats, resembling hand-milking, the inventor being an American named Mayor; and many machines of this type have been experimented with both in America and Europe even up to the present time. However, it is now a well-recognised fact that milking by suction is the most satisfactory and natural method, and most nearly resembles the action of the calf when sucking.

Suction machines were first used in America in 1878, and the use of this system, which was gradually improved, spread over Europe and Australasia.

Early in the eighties, Scotsmen began to work on milking machines, the first machine patented in Scotland being that of Murchland of Kilmarnock in 1890, on the working of which the late John Speir reported in the Society's 'Transactions' for 1892. Mr Speir had himself experimented with a milking machine between the years 1875 and 1881, and he reported of the Murchland machine that though it did not milk well enough to satisfy the average farmer, where hand-milking was difficult to accomplish, mechanical milking could be tried without anxiety as to the result: good work could be done if interest was taken in the working of the apparatus, which worked on a system of continuous suction, the defect of which is that it interferes with the circulation of the blood and produces congestion in the teats and udder.

Shortly afterwards, Gray and Nicholson of Stranraer invented a very similar machine with horn teat-cups, and in 1895 Dr Shields of Glasgow brought out the Thistle Mechanical Milking Machine, which marked a great step in advance, as the injurious system of continuous suction was replaced by inter-

mittent suction or pulsation. The machine, however, had the disadvantage that as the pulsator had to be placed close to the power, and frequently some distance from the byre, the large volumes of air passing through the tubing were therefore very injurious to the milk, more particularly as it was found that some milk got into the pipes.

In 1897 the Highland and Agricultural Society held a competitive trial of milking machines in connection with their Show at Glasgow. The Thistle and Murchland machines competed, and were seen at work at various farms by the Committee, who awarded the prize of £50 to the Murchland machine. It is interesting to note here that as late as July last a Murchland machine was in regular use at the farm of Mr Robert Leiper, Yardbent, Strathaven, and he expressed himself as satisfied with it; unfortunately, owing to a temporary breakdown, it was not seen at work during this inquiry.

Though it was unsuccessful at the above-mentioned trial, it is from the Thistle machine that the more recent milking machines have evolved, such as the Lawrence-Kennedy and the Wallace. The former was invented by Messrs Lawrence & Kennedy of Glasgow, the latter by Messrs Wallace of Castle-Douglas in 1907; in each case the suction is intermittent, this effect being produced by pulsators.

Recent Developments.

During the last ten years there has been a great development in milking machinery, and in 1913, when the Royal Agricultural Society of England held a trial of milking machines at Bishop Auckland, seventeen machines were entered, twelve competed, of which three milked by external pressure on the teats, the remainder by suction; and, whilst one of the pressure machines did good work, the bacterial infection of the milk through exposure to the air was too great, and the Judges awarded the prizes to two machines of the suction type, preference being given to a Swedish machine in which there was a minimum of indiarubber tubing used, the Judges therefore considering the machine was less expensive in upkeep and more easily cleaned.

Origin of this Inquiry.

In January 1916, at the meeting of the Board of Directors of this Society, on the motion of Mr William Poole, it was agreed that the Implement Trials Committee should consider in what way the Society could assist in increasing the use of milking machines in Scotland, and report. At the February meeting of the Board of Directors this Committee reported that they

had decided to prepare a Schedule of Inquiries, to be sent to all users of milking machines in Scotland, with a view to obtaining material for consideration by the Committee. This report was approved, and a Sub-Committee, consisting of Mr J. T. M'Laren, Convener, Mr Charles Douglas, D.Sc., Dr David Wilson, Mr Alexander Cross, Mr William Poole, Mr John M'Caig, and the Secretary, was appointed to draft the Schedule and deal with the replies received.

Schedule of Questions.

The following Schedule was then drawn up and sent out, as far as could possibly be ascertained, to every user of a milking machine in Scotland—viz.:—

1. What is the name of the milking machine you are using, and who are the makers? How long have you had it in use?

2. What is the maximum number of cows it is fitted to milk, and what is the daily average number of cows milked? Do you use it all the year round?

3. What source of power do you employ? State the horse-power; and if an oil or petrol engine, the maker. Does this engine do other work, and if so, what work?

4. If your machine works by suction, what type of pump do you employ? What pressure, as indicated by gauge, do you find necessary? In your machine, what is the proportion of pulsators to cows milked?

5. What is the average time required to milk the above number of cows, and how many persons are required? Are the cows hand-stripped after the machine, and about what quantity of strippings do you get per cow? Is there any difficulty in keeping each cow's milk separate?

6. Have you ever found any irritation or injury to the teats of a cow from the use of the machine? Do cows take readily to its use? Have you had cows that held up their milk, or were so fractious with the machine that they had to be milked by hand? If so, about what proportion? How soon after calving do you begin to use the machine?

7. Have you any records, or failing that, have you formed any estimate of the difference in the yield of milk, or the length of the lactation period, when your cows were hand-milked and when milked by machine? Is it easier with the machine to prevent impurities getting into the milk? Does the milk keep longer sweet? What is your experience of taints arising through the use of the milking machine?

8. What is your method of cleaning the machine, and what time does it require daily? Do parts require more perfect cleaning periodically, and what does this amount to?

9. What was the total cost of your installation? Were there special circumstances in your case affecting this cost—such as situation or construction of byres, or extra power of engine for other uses?

10. Can you state approximately the average total annual cost of running your installation apart from labour, including oil, &c., for engine, replacement of rubber connections and other parts, and repairs generally?

11. In what particulars do you consider there is room for improvement in your machine—especially in regard to (*a*) simplicity in mechanism, facilitating ease in working and efficiency of cleaning; (*b*) saving in wear of parts; (*c*) easy adaptation to any size of teat, and comfort of cow; (*d*) obtaining milk as free from impurity as possible under practical conditions?

If you were installing milking plant now, what changes would you make in your engine, pump, or fittings?

12. Have you experience of more than one type of milking machine? If so, compare their merits.

13. Does the success of your machine depend on continuous personal supervision? Are there recurring difficulties or occasional breakdowns which cannot be overcome by a byreman of average intelligence?

14. Any additional remarks about milking machines that would further this inquiry.

Response to Questions.

Out of 174 forms sent to various farmers in all parts of Scotland, 135 replies were received, which must be considered a satisfactory response.

The Committee then decided to appoint an expert to perform the following duties:—

(1) To consider the replies received to the Schedule of Inquiries.

(2) To visit certain of the farms where machines were at work.

(3) To draw up a report for the consideration of the Directors.

With the approval of the Board of Directors, the writer was appointed as expert; and having considered the replies to the Schedule, he made a tour of inspection early in August.

Tour of Inspection.

Commencing at Dumfries on 3rd August, 35 farms were visited, as shown on the accompanying itinerary; 22 machines

ITINERARY—TOUR OF INSPECTION.

Date.	Morning.		Afternoon.	
	Farm.	Type of Machine.	Farm.	Type of Machine.
August 3	*Crichton Royal Institution*, Dumfries	Wallace	West Roucan (M. & J. Lindsay)	Lister
			Hazliebrae, Lochmaben (R. Nairn)	"
August 4	*The Pleasants* (J. Wyllie)	Lister	Kirkhouse, Kirkbean (J. G. McMyn)	Wallace
	Tinwald Shaws (A. Wilson)	Vaccar	*Torrorie*, Preston Mill (W. Cochrane)	"
			New Mains, Preston Mill (T. Sloan)	Lawrence Kennedy
August 5	*Chapmanton* (H. W. B. Crawford)	Wallace	Heighton, Kirkcolm (W. Cochrane)	Lawrence-Kennedy
			Glengyre, Kirkcolm (W. Kennedy)	"
			North Cairn, Ervie (Geo. Cochrane)	Lister
August 6	*Knockdon* (A. Cross) .	Lawrence-Kennedy, Amo, Wallace, Lister	Lagg, Ayr (A. Harvey Stevenson)	Wallace
			Dunduff (Jas. Hamilton)	"
			Drumshang (G. Sloan)	"
August 7	*Wheat Park, Ayr* .	Amanco	Crofthead, Tarbolton (R. Drennan)	Lawrence-Kennedy
	Aitkenbrae (T. C. Lindsay)	Wallace	*Mossbog*, Mauchline (J. Borland)	Lister
			Mossgiel (A. Wyllie) .	Amo
			Carston, Ochiltree (J. Murray)	Amanco
			Lessnessock (A. Montgomerie)	Wallace
August 8	*Sandyford, Monkton* (G. Young)	Amanco	Interview with Prof. Drummond	
	Newlands, Darvel (J. Alston)	Lawrence-Kennedy	Skerrington Mains, Hurlford (G. Young)	Wallace
	Hill House, Galston (J. Drennan)	Wallace	Boghead, Galston (R. Stevenson)	Lawrence-Kennedy
August 9	*Woodilee Mental Hospital*, Lenzie	Lawrence-Kennedy	*Carbeth, Killearn* (Dr D. Wilson)	Wallace
	Easter Cadder (R. Findlay)	"		
	Interview with J. Campbell Murray, Esq.			
August 10	*En route* Campbeltown	...	Aucharua (J. Barbour)	Lister
			Oatfield (D. Sommerville)	"
			Bellevain (Mrs C. Gilchrist)	Gane
			Tourloch (A. Graham)	Wallace
August 11	Motor car failed to turn up. Should have visited West Backs (Gane)	...	Returned to Edinburgh	

N.B.—At those farms in *italic* the machine was seen at work.

were seen at work, and other machines were inspected and the farmers consulted as to their experiences and opinions.

In all, 8 farms were visited in Dumfriesshire, 1 in Kirkcudbrightshire, 3 in Wigtownshire, 16 in Ayrshire, 2 in Dumbarton, 1 in Stirling, and 4 in Argyllshire. The machines seen at work were as follows:—

Amanco . .	3	Lister . . .	5
Amo . . .	1	Wallace . .	8
Gane . . .	1	Vaccar . . .	1
Lawrence-Kennedy	4		

Types of Machine.

At this point it would be well to give a brief description of the various machines used in Scotland at the present time. As they are all suction machines, working by suction and intermittent pressure combined through a pulsator or other similar arrangement, the main principles of this type of machine may be given first.

General Points of a Suction Milking Machine.

In almost every case suction is developed by a vacuum-pump, either single or double acting, worked by any of the usual sources of power on a farm—water, steam, oil, petrol, or electricity. A vacuum of about 14″ to 19″ is thus obtained, and is transmitted to the byres through pipes usually running the length of the byre over the heads of the cows. Between each pair of cows is either a single or double stall-cock, to which can be attached a flexible tube, the lower end of which is connected to the actual milking machine, standing between the cows, which is of course movable from stall to stall. The suction actuates a pulsator, which by a moving piston-valve produces an alternate suction and pause, or rest, thus resembling the intermittent sucking of a calf. This pulsator generally rests on the top or mouth of the milk-can or receiver, which stands between the pair of cows, and which is tightly sealed by the action of the partial vacuum within. The pulsator is usually connected by two rubber tubes—one for the suction, the other for the milk—to a junction or claw, from which lead four or eight short tubes to the teat-cups—*i.e.*, an air-tube and a milk-tube to each teat-cup.

The cups are made of aluminium, gun-metal, or brass, and are sometimes nickel-plated, for cleanliness and ease in cleaning. As a rule they have an indiarubber lining, and when the vacuum acts on the interior of the teat-cup and air is admitted

between the rubber lining and outer wall, the rubber contracts, grips the teat, pressing out the milk, which is drawn into the bucket by the suction. A little air is also often admitted into the milk-tube to aid the flow of the milk.

Wallace.

Taking the machines in the order in which they were inspected, the first was the Wallace, manufactured by Messrs J. & R. Wallace of Castle-Douglas. It is generally worked by a 3-4 H.P. engine, with a double-action suction-pump, and works at a vacuum of 15″ to 19″, 16″ to 18″ being most general. It is always used with single cans or receivers, that is, one to each cow, and there is no pulsator on the top of the can, but a small pulsator on each teat-cup, the makers maintaining this gives a more efficient milking. The teat-cups carrying the pulsators are thus much heavier than usual, but this, it is claimed, is an aid to rapid milking, the same effect being produced in other machines by the attachment of leaden weights. The four pulsators being placed on the teat-cups reduce the amount of indiarubber tubing, as it is therefore a single-tube machine, and there is only one tube leading from each cup to the claw, and one from the claw to the receiver. The rubber linings to the cups are somewhat triangular in section, and very stoutly constructed, with a metal or rubber mouthpiece to grip the teat.

Lister.

In the Lister machine, manufactured by R. A. Lister & Co., Ltd., Dursley, England, we have a three-way joint, one way fixing into the stall-cock, which is on top of the air-piping; from the other two ways there are two flexible tubes, one to each side of the pulsator, which is placed on top of the bucket or receiver, which latter may be either a double can to milk two cows at once, or a single can as in the Wallace machine. The teat-cups are of the usual type as before described; the rubber lining is a plain cylindrical tube, and not nearly so thick and strong as in the Wallace; the lining folds back over the cup and is covered by a metal mouthpiece. There is an observation glass at the end of each milk-tube on the top of the bucket, and, as this is a double-tube machine, there are both milk- and air-tubes from each cup.

Vaccar.

The Vaccar machine, manufactured by the Vaccar Co., Denman Street, London, S.E., is very similar to the Lister, working at a

vacuum of 15″ to 17″. There is one tube from the stall-cock to the pulsator on top of the can, which may be single or double according to choice; being a double-tube machine, both air- and milk-tubes lead to the claw and on to the teat-cups, which have metal mouthpieces. The rubber linings grip the mouthpieces, in each of which is a small needle-hole, which is known as "the Gillies" hole; this admits a little air around the teat, which the makers claim is much better for the cow. The rubber lining is elliptical in shape, not so stout as in the Wallace, and is fixed at the bottom of the cup by a circular metal disc, through which the milk-tube passes, and which is secured by a check-nut.

Lawrence-Kennedy.

This machine is manufactured by Lawrence-Kennedy, Ltd., 570 Pollokshaws Road, Glasgow, and has two main types —the B.L.K., or Burrell-Lawrence-Kennedy, and the L.K.G. system. The former is a single-tube machine with a metal funnel-shaped cup with no lining, but an indiarubber mouthpiece, with a single suction-tube from each set of cups to the milk receptacle. In the L.K.G. type we have the teat-cup with a rubber lining, and connected by a double set of tubes to the pulsating device and milk receptacle. The B.L.K. system has two types of pulsator—the B.L.K., of which "E" is the latest model, and the Victor, which has two separate pulsating pistons in the double apparatus for two cows.

The L.K.G. pattern has again two main varieties of pulsator —the Phœnix, which is the older pattern, and the Colonial, but they are alike in their action.

The milk receptacles are of two types, either the older fashioned, truncated cone shape, or the more modern, squat, bottle-shaped can.

As the result of his great experience in these matters, Mr Lawrence gives it as his opinion that with the B.L.K. type of cup it is generally advisable to have two sizes of teat-cups, which require judgment on the part of the operator as to when they are to be used.

Amo.

The Amo is a Swedish machine, sold in this country by The Dairy Supply Co., Ltd., of Edinburgh and London. Working at 12″-15″ vacuum, there is the usual system of connection from the stall-cock to the pulsator, which is fitted on the rear of a circular receiver, which is cow-borne, being suspended by webbing under the cow, and in front of the udder. The cups are much the same as in the Vaccar or Lister, but the rubber

lining is a plain cylindrical one. The milk-tubes lead from each teat direct to the receiver, and are made of celluloid; they are transparent, are much more easily cleaned, and much less perishable than rubber, for, whilst steam softens them somewhat, they soon regain their shape on cooling, and are practically unbreakable; and they support the teat-cups, so that if the teat-cups are dislodged they do not fall to the ground. The milk-tubes enter the milk receptacle through rubber-ring washers, which allow of movement up and down and backwards and forwards, so as to suit the shape of the udder and position of the teats. The milk receptacle is oblong with rounded corners, or circular, and not so deep as is usually the case, as it is cow-borne; however, it holds three gallons, which is sufficient for the morning yield of any cow.

Amanco.

The Amanco, which is supplied by the Associated Manufacturers' Company, 72 Mansell Street, Aldgate, London, E., is quite a different machine in its pulsating arrangement to any of the foregoing; it has no vacuum-pump, but the engine or motor drives on to a pulley with a crank-shaft, which gives a to-and-fro motion at a speed of 45 strokes per minute to a long, square, wooden shaft or drive-rod, running the whole length of the byre over the cows' heads, supported on a light beam. Over each cow on the movable shaft is a wooden stop-block, and on to it drops and is fastened the plunger of a light movable pump, somewhat like a garden syringe in principle. The brass pump-barrel itself is fixed to the light stationary beam, and as the drive-rod moves to and fro with a stroke about 15″ in length, it forces the plunger backwards and forwards in the pump-barrel, giving an alternate suction and compression, transmitted by a flexible suction-tube down to the valve-chamber on the top of the milk receptacle, which is a light one of three-gallon size, in shape a truncated cone. The vacuum is admitted only into this valve-chamber, and not into the receptacle or pail, and the chamber has a simple gravity-valve, its only movable part, which is opened and released by the action of the pump; it is therefore possible to lift up the lid and valve-chamber at any time to see how the milk is flowing, and to substitute another pail if necessary. A single rubber tube leads to the claw or junction, and from it four short tubes to the cups, which are of the B.L.K. type of plain, tapered, spun metal, with a rubber mouthpiece, but no lining of course. The warm air from the valve-chamber is discharged at each stroke of the pump, and a small screw with a spiral spring on the pump-barrel regulates the amount of vacuum.

Gane.

The Gane Machine is manufactured by the Gane Milking Machine Co., Auckland, New Zealand, its feature being that it has a simple, single pulsator fixed overhead in the byre, one pulsator serving for any size of byre up to 20 cows, thus avoiding a pulsator for each machine as in other types. Instead of rubber flexible tubes from the stop-cock to the milk-pail, the greater part is a nickelled metal pipe with short rubber ends; the pails can be single or double. The machine is a double tube, and the teat-cup linings are plain and cylindrical in shape; they can be used with or without metal mouthpieces to the cups; the lining is fastened at the top by doubling back over the cup, and at the bottom by a tapered plug, and is simple in construction.

Analysis of Replies to Questions.

In considering the list of questions sent out to users of milking machines, and analysing the replies received, 113 may be classed as being satisfactory, 5 as doubtful, and 7 as unsatisfactory, and of the latter one case was that of a type now obsolete. From these figures it is quite apparent that milking can be satisfactorily done by machinery if care is taken in the working, as proved by the statements of users throughout Scotland. And whilst it is natural that a man who has invested a sum of £100 or thereabouts in the purchase of a milking machine is not likely to decry his purchase if it were not satisfactory, and would be anxious to make the best of it, even that bias is discounted by the fact that those satisfied users include the names of some of the greatest prize-winning cheese-makers in Scotland, as well as many of the owners of the best herds of Ayrshire cattle. It cannot be gainsaid, therefore, that machine milking is a practicable proposition when properly supervised and carefully operated.

Of the 135 returns received from all sources, 60 were using or had used the Wallace machine, 27 the Lawrence-Kennedy, 23 the Lister, and 15 various other types, including 4 Amanco, 3 Amo, 3 Thistle, 2 Gane, 1 Alpha, 1 Vaccar, and 1 Murchland; and whilst these replies do not cover all the users of milking machines in Scotland, yet they may be taken as being thoroughly representative.

Period Machines Used.

The period during which the machines had been in use varied from a few days up to twelve years, and even sixteen years in the case of the sole surviving Murchland machine, the

average time being about three and a half years, so that it will be agreed the trial has been quite lengthy enough to absolutely prove the success or failure of this method of milking; and when it is remembered that at least four makes of the machines in use have been on the market for less than three years, it must be agreed that the older types have proved a practical success by a long usage, averaging over four years for the two types most generally used.

Number of Cows Milked.

The number of cows which could be milked varied from 29 to 94 in the case of the Wallace, with an average of 54; in the Lawrence-Kennedy it varied from 30 to 116, with an average of 49; in the Lister it varied from 24 to 100, with an average of 49; in the other makes from 12 in the case of an Amanco, to 90 in the case of a Thistle, now disused, the average being 43. From these figures it will be seen that the use of a milking machine is not confined to large dairies, though doubtless it is more usually found and more profitable to use with a fairly large herd.

Time of Year Machines Used.

The number of months the machines were used in any year depended on the nature of the dairy; in milk-selling dairies they were used all the year round, but on cheese-making farms, as a rule, the machine is not brought into use in the spring till a fair number of cows have calved, and such a number as would warrant the expense of running the engine or motor, the number being more than could be hand-milked by the limited number of dairy workers kept on such farms, the machine usually coming into use early in March, and, as a rule, being used till late in October, varying from six to ten months.

Several users preferred to dry off their cows by hand, believing that thereby their period of lactation was lengthened, but no user produced any definite data to prove that this assumption was correct.

Source of Power.

The source of power usually employed was an oil-engine, though steam or a steam-ejector was used in 10 cases, and water in 17 cases, usually supplemented by oil in case of summer droughts; electricity was used in 4, gas in 1, and petrol in 29 cases. Gas, of course, is usually only available near a town; and whilst the petrol engine is quick-starting, owing

to high prices and the scarcity of this spirit, many users were trying to run on oil after starting with petrol. In one case only the pressure was obtained from the flow of water from a tank.

The horse-power used varied from 1 to 16; but in almost every case where the engine was over 4 H.P. it was used to do other work on the farm, such as threshing, chaff-cutting, pumping, pulping roots, &c. From 2½ to 4 B.H.P. seemed to be the usual power of engine used for a milking machine, and in several cases even these small-powered engines were used for other purposes on the farm, such as churning, pulping, &c.; in fact, any work that lay within their power. In all, about two-thirds of the engines were used only for milking. It was noticeable, however, that several users stated that if they had to effect any improvement, they would use a higher-powered engine as being more satisfactory; the more recent types of machines with petrol engines, however, seemed to demand less power.

Pump and Pressure.

The type of pump employed varied of course with the make of milking machine, being either single or double acting—more often vertical than horizontal.

The pressure as indicated by the gauge varied from 12″ to 20″, that most generally used being 15″ to 16″, being generally rather higher in the case of the Wallace than with other machines.

Pulsators.

As to the number of pulsators used in proportion to the number of cows milked, this varied from one to 12 up to one to 25; unfortunately, this question was rather misunderstood by many users, so that the answers were in many cases unsatisfactory. More pulsators are of course required where single machines are used than where two cows are milked at a time: in one case of this kind 6 single pulsators were used for 75 cows; in another case 3 double pulsators for 64 cows. In the Wallace machine, of course, there are 4 small pulsators to each machine, so that really the proper basis is the number of cows milked for each machine used, and this varied from one machine to 12 cows with single machines up to 1 to 25 cows with double machines.

Time.

As to the average time taken to milk the cows, this worked out at 4 to 5 minutes per cow; but of course this varied with

the skill of the operator, whether the machines were single or double, whether the cows were difficult to milk or otherwise, and the amount of assistance given to the operator. In some cases he both milked and stripped and carried away the milk; in others he only milked, the stripping, &c., being done by other workers, thus lessening the time per cow; but an average man should with ease milk, strip, and carry away the milk of 12 to 16 cows per hour, and thus effect a saving of at least 50 per cent in the number of milkers required, and in many cases the machines were operated by women, who did the work very well indeed. Three persons with a milking machine could milk 70 to 80 cows in less than 2 hours, whereas 7 or 8 hand-milkers would be necessary.

Stripping.

In the great majority of cases the cows were hand-stripped, though 16 users stated that they did not do so, and in 7 or 8 cases the reply was that only a few were stripped. It may be taken, therefore, that as a rule it is better to hand-strip, for, whilst some cows give very little strippings, especially those that have been milked by the machine as heifers, yet others hold back a considerable quantity of milk, and the effect of leaving this in the udder would be to considerably shorten the period of lactation, and very often to produce mammitis.

The quantity of strippings per cow varied from $\frac{1}{4}$th pint to 2 pints as a rule, though in two cases where machines are now disused it was given as 16 per cent, and up to 2 gallons per cow, respectively; as an average, half a pint per cow would be about what one might expect.

In every make of machine provision is now made for keeping each cow's milk separate, either by the use of single cans or divided double cans.

Effect on Cows.

Only four users complained definitely of irritation to the cows' teats caused by the machine, whilst six make the remark that there is very little irritation; the rest all say that there is no irritation whatever. During the inspection a slight numbness and swelling of the teats was noticed after the use of the Wallace machine, but this had disappeared in less than ten minutes, leaving the teat soft and quite normal; and the users agreed that this swelling had no after effects, as indeed was proved by the milk records.

It was stated, almost without exception, that cows take

readily to the machine; there are, of course, many cows of a nervous temperament that withhold their milk even when hand-milked, if frightened or struck; and there are undoubtedly some which will not milk to a milking-machine because they are nervous and dislike the noise, perhaps; but the proportion is small—many users had no fractious cows; some said they had as far as 10 per cent; but the average number of fractious cows which would not milk to the machine would appear to be under 3 per cent, and this is borne out by other experience. It was generally agreed that cows which had been milked by the machine as heifers were much better to milk, milking out more cleanly than cows which had been hand-milked for the first two or three lactation periods.

The time allowed to elapse after calving before the cow is milked by the machine was again very different in different herds. In some cases the machine was used immediately after calving, in others not for ten to fourteen days afterwards; but in most cases the cows were milked by the machine as soon as the milk approached the normal, and was fit to use for cheese-making or for sale, which, generally speaking, was about the third or fourth day—taking an average, probably the third day; an old set of teat-cups are often kept for this purpose, and used for the first two or three days of machine-milking.

Comparative Records.

In most cases no comparative records had been kept to show whether the cows gave more or less milk when the machines were used; but where they had been kept the result was nearly always in favour of machine-milking.

Taking individual cases—Mr J. G. McMyn of Kirkbean—hand-milking in 1914 had an average yield of 609·7 gallons, whilst in 1915, with machine-milking, the average was 760 gallons—a big gain, always bearing in mind that 1915 was a better milking season.

Mr Weir of Kells had a worse yield first year, but blamed the working of the machine.

Mr J. B. Stevenson of Chapelcroft had increasing records every year, but while of opinion that good hand-milking is superior to machine-milking, yet the latter is so satisfactory that he would never think of undertaking a large dairy of cows without the mechanical milker.

Dr Wilson of Carbeth has complete records, from which the following were abstracted as being strictly comparable in regard to season of calving and other conditions—viz., the average yield of 16 cows in 1913 with hand-milking was 674 gallons,

whilst in 1914, with the machine installed, the average yield was 720 gallons for the same 16 cows. Eleven of these cows calved at the same season in 1915, and gave an average of 778 gallons.

At Sir Mark M'Taggart Stewart's farm at Barrhill, Ardwell, in 1915, 56 cows, machine-milked, averaged 651 gallons per annum, whilst 48 cows, hand-milked, yielded 624 gallons per annum, the hand-milked cows averaging 3·84 per cent of fat, as against 3·90 per cent from the machine-milked animals.

Mr Alexander Wyllie of Mossgiel, Mauchline, had an increase of 30 gallons per cow in 1915, which he attributed to the use of the machine.

Mr James Borland of Mossbog milked one half by hand and the remainder with the machine for one season, and found no difference in the yields; whilst Mr John Barbour of Aucharua, Campbeltown, in his first season had a yield of 81 gallons per day for the ten days ending the 26th June, when the cows were hand-milked; and for the following ten days, when he commenced machine-milking, the yield was 78 gallons daily, the falling-off being less than one pint per cow, and all, in his opinion, due to the natural decline of the cows as the season progressed, the cows being all March calvers.

These cases are taken as being definite records, the figures being given; but in many other cases the users said that the yields are quite as good, if not better, by machine-milking, stating that they kept records, but giving no figures; and in very few cases is it alleged that the records are worse than when hand-milked. These figures would seem to prove that machine-milking certainly does not lessen the yield of milk; but at the same time the total gain cannot be claimed as being entirely due to machine-milking. Several farmers expressed the opinion that cows dried off quicker in the autumn when they were machine-milked, and therefore it was better to milk them by hand at that period of the year; but no one gave any definite records to prove that this was the case, and, of course, others gave a directly opposite opinion.

Effect on Milk.

With two exceptions only, every user agreed that it was much easier to prevent impurities getting into the milk with machine-milking; and as in both of these exceptions the use of the machine had been an absolute failure, and had been abandoned, it is in every way likely the machine was not to blame, but rather those working it.

With regard to the keeping properties of machine-drawn milk, the opinion again was very strong in favour of the

milking-machine, only six users saying that it did not keep as well as hand-drawn milk, though several gave no opinion.

As to taints arising, only twelve out of the whole number complained of this, and some of these qualified their complaints by saying that these would not have arisen had the machine been properly cleaned; as most of the users were cheese-makers, and made no complaint, this seems ample evidence that with ordinary care taints need not occur.

Cleansing Machines.

In the cleansing of the machines there were very great differences in practice. Some users boiled the rubber parts once a week for a short time, and insisted on the importance of doing so; others never used boiling water at all, to the advantage of the rubber, if not to the benefit of the milk, as the rubber parts of the machine are practically the only parts which need renewal. As rubber is so expensive, it seemed there ought to be some standard and proper way of cleansing the rubber parts of the machines, which, whilst efficiently and properly cleansing them, injured the rubber itself as little as possible.

Professor Drummond of Kilmarnock, the well-known dairy expert, being interviewed, was kind enough to give the full benefit of his experience in this direction, which could well be followed by all users of milking machines as being the best-known method of preventing taints, promoting cleanliness, and preserving rubber.

Professor Drummond recommends that the whole of the machine which comes in contact with the milk should be thoroughly washed, first in warm water; next in hot water, *not* boiling; and finally, the rubber parts should be immersed till required again in a solution of formalin, the strength being half a liquid ounce to a gallon of water.

Dr Lauder, of the East of Scotland College of Agriculture, recommends almost the same method, except that, after washing with hot water, he advises soaking in a solution of caustic or washing soda, half a pound to the gallon of water, before immersing in the formalin solution, which he thinks should be made half a gill to the gallon.

Some makers advise washing in cold water first, though lukewarm water is much more efficient as a cleanser; but it must be lukewarm, and not hot. It may be added here that the use of formalin is strongly advised for the cleansing of all dairy appliances by Professor Drummond.

Generally speaking, the teat-cups, tubes, &c., were washed after using in cold or lukewarm water, and then in hot

water; and wehn properly cleaned they were immersed in some antiseptic—such as formalin, steriline, or washing-soda, although some dairymen condemn the use of the latter.

In addition to this, on an average the machines were taken apart and thoroughly cleansed once a week,—though here, again, there was a great difference in practice—some doing it two or three times a week, others once a month; but once a week would appear to be sufficiently often, and the time taken was given as one to two hours, according to the size of the installation, say 2 hours for a 50-cow installation. The tubes would then be cleansed with brushes, pulsators adjusted where necessary, &c.

In the ordinary daily cleansing, as a rule, the tubes were only cleaned by suction, a stall-cock similar to those in the byre being provided at the dairy near the hot-water supply, and lukewarm and hot water drawn through the tubes intermittently so as to give a greater cleansingeffect.

The Wallace machine, owing to its having a small pulsator on each teat-cup, takes more cleansing than other types—on an average one hour daily, as compared with half an hour, and even less, for other machines.

Cost.

Next, coming to the total cost of the installation, this runs from 30s. to £3 per cow, £2 being a fair average where there are no special circumstances—such as byres being wide apart, &c. The milking machine itself costs about 30s. per cow, apart from the cost of the engine or motor. In the case of machines worked by a petrol motor, the cost seems somewhat higher than in other cases—as, for instance, the Lister, which, with motor complete, works out at £2, 10s. per cow. Of course at the present time figures are higher for all machines, and from information supplied from several makers the cost now runs at from 40s. to 60s. per cow for a 40-cow installation, exclusive of power, or 53s. 6d. to 75s. including the motor or engine. For an 80-cow plant the cost would be from 37s. 6d. to 44s., or from 43s. to 54s. with the motor; and for an installation for 120 cows the cost would run from 38s. to 40s., or with motor included 40s. to 47s. per cow.

It must be remembered that the larger the herd of cows, the more widely spread are the byres as a rule, which of course increases the cost of the installation, and for this reason the larger plants are not so much cheaper in comparison as might be expected. The following table gives the approximate costs of various types at the present time, as supplied by the different makers.

TABLE SHOWING COST OF INSTALLATION OF MILKING MACHINES.

Make of Machine.	Cost without Engine.			Cost with Engine.			Notes.
	For 40 cows.	For 80 cows.	For 120 cows.	For 40 cows	For 80 cows.	For 120 cows.	
Hinman-Amanco	£85 0 0	£150 0 0	£218 0 0	£107 0 0	£172 0 0	£240 0 0	$2\frac{1}{4}$ H.P. Engine.
Gane . .	115 0 0	175 0 0	220 0 0	141 10 0	201 10 0	256 15 0	$2\frac{1}{2}$ H.P. Engine. 4 H.P. for a 120-cow installation.
Lister . .	(No	figures	given.)	140 10 0	228 0 0	309 0 0	$2\frac{1}{2}$ H.P. Engine for 40 or 80 cows. 4 H.P. Engine for 120 cows.
Lawrence-Kennedy	100 0 0	176 0 0	228 0 0	125 0 0	221 0 0	278 0 0	...
Vaccar . .	89 9 8	140 14 3	197 10 0 (for 125 cows)	121 0 0	181 18 0	229 10 0 (for 125 cows)	Time allowed in each case for herd-milking—100 minutes.
Wallace .	80 0 0	160 0 0	240 0 0	122 0 0	202 0 0	282 0 0	...

The above estimates are all for fairly normal installations, no undue lengths of piping, &c., &c., and as a rule do not include cartage, mason, or joiner work.

A 20-cow installation would cost from 50s. to 80s. per cow, exclusive of any power.

Information with regard to the cost of running is, unfortunately, somewhat vague, and no definite averages could be drawn. At Barrhill, Ardwell, £12 has been the average annual cost of upkeep for the past six years, the number of cows usually milked being 56. An oil engine is used, the oil for which costs £30 per annum, giving therefore a total cost of 15s. per cow; but the engine here is 8 H.P., and does other work.

At Southwick, for ten years the average cost has been £8 for oil, £7 for repairs and refits—*i.e.*, about 4s. per cow; at the Crichton Institution, for lubricating oil and repairs to the machine, only 2s. 6d. per cow; at Chapmanton, with oil at recent prices, the cost is 7s. per cow per annum, inclusive of oil and all repairs; at Carbeth the total cost is about 9s. per cow; but it is very difficult indeed to give an average figure, as in many places the engine does other work, and again, a careless byreman will use far more linings than is necessary, especially of the lighter types like the Vaccar or Amo, owing to clumsiness in handling when cleaning.

SUGGESTIONS FOR IMPROVEMENTS.

With regard to the suggestions for improvements, it is said of the Wallace machine that it has too many pulsators; on the other hand, it is stated that it works more quickly on this account, and milks out more thoroughly. Another suggestion is celluloid milk tubing, which would necessitate a cow-borne receptacle as in the Amo, which is not quite so easily handled; certainly the celluloid tubing is more cleanly and less perishable than rubber.

One user suggested "more pulsation and less suction," as in his opinion it would milk more quickly, and in this respect it may be pointed out that the Wallace in speed more nearly approaches the speed at which a calf sucks than any other machine. Some farmers work at a slightly higher vacuum in winter than in summer, but this is not general.

Opinions differ with regard to the mouthpieces of the cups; some suggested one size for all cows, whilst others considered there should be two sizes. It certainly seems if milking can be done satisfactorily with one size of mouthpiece that it is more satisfactory, avoiding redundancy of fittings and alterations whilst working.

In one case a noiseless pulsator is suggested, which certainly would be an improvement for nervous cows if it were possible. One Lister user stated that it would be better if the suction

could be turned off the front teats if necessary, as the hind teats usually take longer to milk; this, of course, is possible with the Amo, but can hardly be considered important, as prolonged suction on the udder seems to have no ill effect, and the suggestion would entail more taps and fittings, which are not desirable, and add to cleansing difficulties.

It is suggested in the Wallace that rubber mouthpieces are better for heifers and for windy teats, as they grip better; the aluminium mouthpieces are generally considered more severe, but they milk cleaner.

On the whole, suggestions for improvements were few in number.

Not more than 10 per cent of the users had had experience of more than one kind of machine,—as a man who puts in a milking machine cannot change it often on account of the initial outlay being so great—and their criticisms of other machines are much as might be expected; as a rule they preferred the machine they were then using, which is but natural.

Personal Supervision.

Two out of every three users were of the opinion that the success of a milking machine depends on personal supervision, which most of them considered ought to be continuous; at the same time, the majority of farmers considered that the average byreman should be able to overcome occasional breakdowns in the machine, though it must be confessed a considerable minority stated this was not the case.

Remarks.

As to the writer's conclusions, he is strongly of the opinion, as the result of this inquiry and his own personal experience, that there are several reliable milking machines now on the market, and their success or failure in everyday use depends entirely on the care bestowed on them and the interest taken in their working; that they are a success when properly used cannot now be gainsaid; the milk records, prize cheese, and prize cattle seen on farms where milking machines were in use are evidence of their success in the dairy world with fair usage, but if reasonable care is not taken they may easily prove a total failure.

The writer having seen each of the machines now used in Scotland doing splendid work on one farm or another, is of the opinion that it is not so much a question of the machine but rather the man who works it. If the farmer or his family are personally interested in the working of the machine,

then it is nearly always worked successfully; if, however, the farmer has to be absent frequently from home, and the machine is left very largely to hired men, then trouble may arise owing to lack of cleanliness and lack of judgment.

Whilst the great essential is good and thorough milking, it would seem that "a minimum of rubber" is the text for makers of milking machines, rubber being expensive, perishable, and not too easy to clean.

A stout lining to the cups is very desirable, as these wear out much more quickly than any other part of the machine; and the writer does not consider the use of milking machines is encouraged by the high prices charged for renewals, to say nothing of the initial cost of the installation.

A frequent source of trouble is the pulsator, which often, through over-lubrication by unskilled hands, clogs up and stops; the fewer pulsators therefore the better; and the less need for any lubrication of the pulsators, the fewer stoppages there will be. At the same time, it is only fair to state the opinion of many users of the Wallace machine, that a pulsator to each teat ensures quick and thorough milking.

In the writer's opinion the single-can type is the best, both for the keeping of milk records and for general working, being more easily handled in every way, though some users are strongly in favour of the double-can type.

The cow-borne receptacle has its advantages in being difficult to dislodge and permitting the use of celluloid milk-tubes, but the shape of the receptacle is not very convenient for emptying, nor is the machine too easy of attachment, unless handled by an expert workman.

Whilst there seemed little to choose between the single-tube and double-tube machines when seen at work, as the metal cups with rubber mouthpieces only seemed quite successful, being durable and easily cleaned, the single-tube machine is now much less often used than the double-tube type.

The new type of machine—*i.e.*, the Amanco—seems very simple, though somewhat flimsy in construction, like much American machinery; it lacks any gauge to show what pressure it is working at, but any pulsator trouble is non-existent; and if after a longer trial it proves a success as a milker, it will doubtless gain ground owing to its simplicity. The users complain of the very high initial cost, and the price does seem absurdly high for so simple an installation.

With regard to power, this is a matter depending on the position of affairs at each individual farm; water power, of course, is very desirable where it is available and reliable. In times of peace, the quick-starting petrol engine will no doubt replace the oil engine to a large extent; and where electricity

is available, it is of course the most convenient of all kinds of power. If the petrol engines after starting can be made to run on paraffin, so much the better, as it gives the farmer two strings to his bow, and oil is certainly the cheaper fuel up to the present; and, where possible, a separate motor or engine used only for the milking machine is, I think, most satisfactory.

The cleansing of milking machines is of paramount importance. It is fortunately fairly easy to accomplish, and the adoption of Professor Drummond's recommendation will undoubtedly lessen the rubber bill and at the same time maintain the quality of the milk. The writer is absolutely convinced that the use of boiling water on rubber is most injurious and wasteful, and at the same time he considers the use of water on the cow's udder, to make the teat-cups grip, is most undesirable from the point of view of cleanliness, and quite unnecessary, as it was not used on the majority of farms.

A farmer who is unable to get good hand-milkers need have no hesitation in installing a milking machine, if he is prepared to give it personal supervision, or if he has a reliable byreman who will take an interest in it. With reasonable care and attention to the thorough cleansing of the machine, satisfactory results should follow always, and the use of the machine will enable many farmers to continue in the production of milk and cheese who otherwise would be unable to do so owing to shortage of labour or unsatisfactory hand-milking. The writer, after this tour of inspection, and a personal experience of machine-milking of over 100 cows for more than six years, is absolutely convinced that milking by machinery can be properly and economically effected, and that milking machines are of practical use and of great value to present-day dairy farmers.

In conclusion, the writer would thank all those concerned for the kindness and hospitality extended to him during his tour of inspection; and whilst all were so kind that it is almost invidious to mention any names, he would particularly thank Mr Cross of Knockdon, Mr M'Caig of Belmont, Mr H. W. B. Crawford of Chapmanton, Professor Drummond of Kilmarnock, and Dr D. Wilson of Carbeth, for information and assistance so freely given, and hospitality rendered.

THE CEREAL AND OTHER CROPS OF SCOTLAND FOR 1916, AND THE WEATHER OF SCOTLAND IN 1916.

THE CROPS.

THE following comparison of the cereal and other crops of 1916 with those of the previous year has been prepared by the Secretary of the Society from answers to queries sent to leading agriculturists in different parts of the country.

The queries issued by the Secretary were in the following terms:—

1. What was the quantity, per imperial acre, and quality of grain and straw, as compared with last year, of the following crops? The quantity of each crop to be stated in bushels. What quantity of seed is generally sown per acre?—(1) Wheat, (2) Barley, (3) Oats.
2. Did the harvest begin at the usual time, or did it begin before or after the usual time? and if so, how long?
3. What was the quantity, per imperial acre, and quality of the hay crop, as compared with last year, both as regards ryegrass and clover respectively? The quantity to be stated in tons and cwts.
4. Was the meadow-hay crop more or less productive than last year?
5. What was the yield of the potato crop, per imperial acre, as compared with last year? The quantity to be stated in tons and cwts. Was there any disease? and if so, to what extent, and when did it commence? Were any new varieties planted, and with what result?
6. What was the weight of the turnip crop, per imperial acre, and the quality, as compared with last year? The weight of the turnip crop to be stated in tons and cwts. How did the crop braird? Was more than one sowing required? and why?
7. Were the crops injured by insects? State the kinds of insects. Was the damage greater or less than usual?
8. Were the crops injured by weeds? State the kinds of weeds. Was the damage greater or less than usual?
9. Were the pastures during the season of average growth and quality with last year?
10. How did stock thrive on them?
11. Have cattle and sheep been free from disease?
12. What was the quality of the clip of wool, and was it over or under the average?

From the answers received, the following notes and statistics have been compiled:—

EDINBURGH DISTRICT.

MID-LOTHIAN. *Wheat*—24 to 30 bushels; crop inferior to last year; about 3 bushels seed sown. *Barley*—32 bushels; 8 to 10 bushels less than last year; 3 bushels seed sown. *Oats*—40 bushels, or rather less than last year; 4 bushels seed sown. *Harvest*—A week later than last year; got very good weather. *Hay*—A fine crop; 3 tons per acre, well got; second crop about 1 ton per acre. *Meadow-hay*—None grown. *Potatoes*—A perfect failure; about 2 tons per acre, and in many cases less than that; no disease. *Turnips*—10 tons per acre, or half of last year; crop brairded well; no second sowing. *Weeds*—No damage by insects or weeds. *Pastures*—Much the same as last year. *Live Stock* throve well. Cattle and sheep free from disease. *Clip of wool* much the same as last year.

WEST LOTHIAN. *Wheat*—Not a big yield—say 5 qrs.; quality, through want of sun, disappointing; straw fair; seed drilled 3 bushels, broadcast 4 bushels. *Barley*—Fair crop; yield, say 40 bushels; straw good; seed drilled 3½ bushels, broadcast 4½ bushels. *Oats*—Threshing well, give 48 bushels; quality good; seed—big oats, 4½ bushels drilled; broadcast, 6 bushels; small oats, 3½ and 4½. *Harvest* general first week of September. The cereals were irregular in ripening, which caused a long harvest; labour scarce; a good number of soldiers released for harvest work. *Hay* crop good, and well got; 2½ to 3 tons per acre. *Meadow-hay*—Good. *Potatoes*—The crop was a complete failure owing to wet spring and want of sun, many farms not yielding more than 2½ to 3 tons per acre. *Turnips*—Crop generally small—say 12 to 14 tons; early sown brairded quick, but got set with the rain; prices extreme—up to £4 per ton. No injury by insects or weeds. *Pastures* bare, owing to wet. *Live Stock* as a rule "grew," but did not put on flesh. Cattle and sheep free from disease. *Clip of wool*—Good.

EAST LOTHIAN (Upper District). *Wheat*—30 bushels; the quality of both grain and straw was much below an average; this was the result of the cold wet season; on heavy clay land the partial flooding in the beginning of July practically ruined the crop; 4½ bushels is now generally sown. *Barley*—32 bushels; the quality of both grain and straw was very deficient, and in clay lands suffered even more than the wheat; on such farms some fields did not thresh 20 bushels; 3½ bushels drilled per acre is about the recognised quantity. *Oats*—50 bushels; did not reach the quality in either grain or straw of 1915 crop; this crop suffered least of all the cereal crops by the unfortunate season; the seeding varies now very much, as the new hybrid varieties require 1½ to 2 bushels per acre more than the standard potato oat; the latter 4 bushels, and the others from 5 to 6 bushels, according to the variety sown. *Harvest* operations were about ten days later than an average, want of heat and sunshine being the reason. *Hay*—2½ to 3 tons per acre; quality first-class; favoured with two weeks of the best weather of the year for harvesting. *Meadow-hay*—None grown. *Potatoes*—2½ to 4 tons; on heavy clay land the worst crop in memory of present generation of farmers, being ruined by the July rains; no disease; some of the newer varieties withstood the unfavourable season best, and will increase in acreage in future years. *Turnips*—10 to 12 tons; suffered like other crops, and to a greater extent on heavy soils; many acres were not seeded until too late to reach

a crop; some resowing was done, with no good results, as land was out of proper condition. *Insects*—No injury by insects. *Weeds*—No more than normal. *Pastures* above an average, with a great flush all season. *Live Stock*—Cattle throve well; sheep suffered from the softness of the grass, due to the extreme growth. Cattle and sheep free from disease. *Clip of wool.*—A full average on the lower grounds.

East Lothian (Lower District). *Wheat*—32 to 40 bushels, in comparison with 44 to 48 last year; quality fair; straw scarcely so heavy as last year; 3½ bushels seed drilled, 4 bushels broadcast. *Barley*—A poor and very variable crop—28 to 44 bushels on an average; 12 bushels less than last year; quality under average; straw small bulk generally, though some heavy and soft crops; 3 bushels seed drilled. *Oats*—A light crop; 32 to 48 bushels of potato varieties; 12 bushels more of thick-skinned varieties; crop on average about 12 bushels less than last year; straw light bulk; 4 to 5 bushels seed sown. *Harvest* late; three weeks later than average. *Hay*—A very heavy first crop; 3 tons per acre as compared with about 2 tons. *Potatoes*—Yield generally miserable; very variable crops; "Dalhousie," about 1 to 2 tons per acre; "Golden Wonder," 2 to 3 tons per acre; "Arran Chief" and other new varieties, 3 to 5 tons. The wet summer caused crop to be the lightest for over forty years; disease in older varieties; crop on many farms a complete failure. *Turnips*—Light crop; 30 per cent less than last year; average crop about 18 tons; crop late sown; brairded generally fairly well. *Insects* not greater than usual. *Weeds*—The wet weather in summer encouraged a greater weed growth than usual, and shortage of labour prevented the usual amount of hoeing. *Pastures*—Above average growth; never so much grass before. *Live Stock* throve fairly well. Cattle and sheep free from disease. *Clip of wool*—A light crop; 10 per cent under average.

BORDER DISTRICT.

Berwickshire (Merse). *Wheat*—38 bushels; straw abundant, and quality fair; seed, 4 bushels per acre. *Barley*—36 bushels; quality only fair; price nearly double the average; seed, 3 to 3½ bushels. *Oats*—42 bushels; more than half the crop, both grain and straw, damaged by bad harvest weather; seed, 4 to 4½ bushels. *Harvest* about same time as last year, but a fortnight later than the average. *Hay*—2 tons; both ryegrass and clover a good crop, and well got. *Meadow-hay*—A big crop—about double that of 1915. *Potatoes*—The poorest crop of the season; 2 to 3 tons; some disease, but not so bad as 1915; usual varieties planted. *Turnips*—Crop generally poor; many fields not sown at all; 10 to 12 tons; swedes better; impossible to get the soil in order for sowing turnips till too late in the season. *Insects*—No damage by insects. *Weeds*—The weeding of turnip drills was almost impossible owing to abnormally wet season. *Pastures* generally luxuriant and of fair quality; clover grew well. *Live Stock* did well generally. Cattle and sheep free from disease. *Clip of wool* under average.

Berwickshire (Lammermoor). *Wheat*—Almost none grown in this district. *Barley*—30 bushels; early crop fair; later much damaged by rain; seed, 3 to 3½ bushels. *Oats*—40 bushels; crop yielding up to expectation; some shedding of grain owing to high winds, and a great deal of both grain and straw more or less damaged by the abnormally wet weather of the latter half of harvest time; seed, 4 to 6 bushels,

according to variety. *Harvest*—About 3 weeks later than average. *Hay*—About an average of 38 cwt., and of fine quality. In the middle of a very wet season there was a fortnight of fine weather, which was most favourable for the clover-hay crop. *Meadow-hay* — Nearly double the crop of 1915, but large quantities absolutely wasted through the almost constant rains. *Potatoes*—About 3 tons; less than half the crop of 1915 ; not much disease ; nothing newer than "Arran Chief." *Turnips*—Only about 12 tons ; a late, poor crop ; cultivation and seeding for turnips were very difficult, and operations protracted owing to continued wet weather. No injury by insects. *Weeds*—In many cases it was not possible to get the weeds killed and kept down owing to shortage of labour and wet weather. *Pastures* abnormally rough and growthy ; quality fair. *Live Stock*—The season, though wet, was not cold, and stock generally did better than might have been expected. Cattle and sheep free from disease. *Clip of wool*—Under average, but fair quality.

ROXBURGHSHIRE. *Wheat*—Almost none grown ; 3 bushels seed. *Barley*—30 bushels ; moderate quality ; straw say 20 cwt. per acre ; from 2¼ to 3 bushels sown per acre. *Oats*—36 bushels ; moderate quality—not well filled ; 18 cwt. straw per acre ; from 4 to 6 bushels sown per acre, according to variety. *Harvest* about usual time. *Hay* a good crop ; ryegrass might average 2½ tons per acre—better than previous year ; 2½ tons clover. *Meadow-hay*—More productive than last year. *Potatoes*—About 2 tons per acre ; disease in places, but not generally ; "Arran Chief" did best. *Turnips* a poor crop ; 10 to 15 tons per acre ; brairded quite well ; not much resowing. Not much damage by fly. *Weeds* not more than usual. *Pastures* above the average. *Live Stock* throve well. Cattle and sheep have been healthy as a whole. *Clip of wool* rather under an average.

SELKIRKSHIRE. *Wheat*—The small quantity grown was good ; 42 bushels per acre. *Barley*—A moderate crop ; 32 bushels. *Oats* below an average crop, and suffered considerably from late harvesting and the bad season ; 30 bushels per acre. *Harvest* ten days late and very protracted, late crops getting very bad weather. *Hay*—Ryegrass hay 2¼ tons, all well secured. *Meadow-hay*—A very good crop, but much of the late hill crop badly damaged. *Potatoes*—A poor crop ; about half the weight of 1915, with more disease than usual. *Turnips*—The turnip crop, on the whole, was below the average at least 25 per cent. The season was much too wet for working the land, and a large percentage of the crop much too late in being sown. No injury by insects. *Weeds*—Any injury to crops from weeds was due to want of labour. *Pastures*—Pastures were satisfactory. *Live Stock*—There was nothing to complain of regarding the way in which stock throve. Cattle and sheep free from disease. *Clip of wool*—A moderate clip ; most sheep in this county would clip from ½ to 1 lb. less than previous year.

PEEBLESSHIRE. *Wheat*—Very little grown. *Barley*—Something like 32 bushels ; about 1 ton straw ; quality of both good ; 4 bushels sown. *Oats*—Something like 32 bushels ; fully 1 ton straw ; quality of both good ; 4 to 4½ bushels sown. *Harvest* fully one week later than usual. *Hay*—35 to 40 cwt. ; quality first class. *Meadow-hay*—Quality good. *Potatoes*—2 to 3 tons ; very little disease. *Turnips*—About 17 tons ; quality good ; brairded well ; very little resowing if any. No injury by insects. *Weeds*—Not to a great extent ; some yarr and runches ; damage much the same as usual. *Pastures*—More grass than previous year. *Live Stock* throve well. Cattle and sheep free from disease. *Clip of wool* a little better in weight, and also in quality.

DUMFRIES DISTRICT.

DUMFRIESSHIRE (Annandale). *Wheat*—No wheat grown in this district. *Barley*—Short both in straw and grain, caused by exceptional spell of cold and wet weather, experienced from 1st to 10th June; yield, 24 to 28 bushels per acre; crop secured in good condition; 4 bushels seed sown per acre. *Oats*—Bulk of straw will compare favourably with last year, but grain very disappointing, especially in yield; very fair, good-coloured, and plump samples on the market; shortage caused by the wet spell in early summer, but principally by frosts in the end of August. This caused premature ripening, and consequently a diminished yield. The crop was secured in good condition on most farms; but in late districts, and where labour was scarce, the farmers were caught by a break in the weather on October 2nd, and thereafter there was no chance of saving the crops in good condition.

A good deal of well-got grain was wasted in the ricks. Some farmers depend too much on the travelling mills, and do not thatch but thresh out of the rick. Owing to daily rainfall after the beginning of October the mills could not work, and the ricks, not being protected by thatch, were damaged. Average yield, about 30 bushels per acre; seed sown from 4 to 7 bushels per acre—7 in the case of the new non-tillering varieties. *Harvest*—Harvesting began about 1st September, a week after the usual time. *Hay*—Ryegrass hay an average crop; owing, however, to scarcity of labour some farmers began cutting sooner; those who did so got a considerable breadth damaged by the heavy rains prevailing during part of June; those who waited lost in quality, as the crop got too ripe, and was woody and coarse. Weight of crop from 35 to 40 cwt. per acre. Clover did well, and there was a suitable proportion in most crops. *Meadow-hay*—The weather in July was ideal for haymaking, and consequently meadow-hay was secured in first-class order and in record time. The crop was exceptionally heavy; but for this crop farmers would have been badly off for fodder. *Potatoes* much below the average; would not average 3 tons per acre; disease prevalent; the only varieties free from disease were "Arran Chief" and "Golden Wonder." The disease was late in showing—not until the crop was beginning to get ripe. *Turnips* in the autumn presented a variable appearance. On some farms the crops seemed an average one; on others they looked poor. Taking the district generally, the crop may be stated at one-third less than the average. The crop brairded well, but early morning frosts cut down the young plants and resowing had to be resorted to on a good many farms. The dry weather in July (so favourable for haymaking) was against the turnip crop. Things went to the opposite extreme in October and November, and the roots did not bulk well when they came to be lifted. *Insects*—Crops were generally free from insect pests. The turnip-fly did some damage, but this was not general. *Weeds*—Owing to the early summer being wet and labour scarce on many farms, weeds were not kept under as they should have been; not a few turnip crops were overrun with weeds. *Pastures* were not of average quality. There was a strong growth, but excessive rain and lack of sunshine, coupled with low temperature at nights, especially in the early summer and late autumn, affected the quality. *Live Stock*, owing to the above facts, did not do so well as usual. Scour was too prevalent amongst cattle, doubtless owing to unfavourable growth. Cattle and horses free from disease; there were one or two outbreaks of sheep-scab traced to the north. The death-rate from braxy was much lower than usual. *Clip of wool* of average weight.

DUMFRIESSHIRE (Nithsdale). *Oats*—35 bushels; on account of cold rainy season both corn and straw were inferior in quality and less in quantity. *Harvest*—About a fortnight later. *Hay*—About 1 ton per acre more, and good quality. *Meadow-hay*—Fully 1 ton more per acre. *Potatoes*—3 tons per acre less; some varieties were badly diseased. It was difficult to tell when it commenced, as some of the shaws went down early in the season. Of the new varieties "Arran Chief" resisted the disease best. *Turnips*—About half the crop of 1915; about 8 tons; quality not so bad, but bulbs small; braird uneven, but came slowly to the hoe; not many sown a second time. *Insects*—No damage by insects. *Weeds*—Crops injured by redshank and spurry—considerably greater than usual. *Pastures*—Average growth and quality of last year. *Live Stock* throve on them very well. Cattle and sheep free from disease. *Clip of wool*—The clip of wool was an average both in quality and quantity.

DUMFRIESSHIRE (Eskdale). *Wheat*—None grown. *Barley*—None grown. *Oats*—A good crop; above average on lea where sown in good time, but on land after turnips was under average owing to wet weather preventing the land being ploughed and sown in good time. Would average about 34 bushels per acre; quality of straw and grain very good where got in before the weather broke in October; seed, 6 bushels on lea and about 5 bushels after turnips. *Harvest* commenced at the usual time—about the beginning of September—and what was housed before the weather broke down in the beginning of October was in good order, but after that date any left out was almost entirely wasted. *Hay*—Ryegrass a big crop; better than last year, and very well got, except a little cut early, which got wet weather and was somewhat spoiled; about 30 cwt. per acre, and a good aftermath. *Meadow-hay*—A fair crop, much the same as last year, and mostly secured in good order; about 23 cwt. per acre. *Potatoes*—The yield this year would be fully ⅓ under last year; they were small in size and very much diseased; would be under 4 tons per acre; disease commenced about beginning of September and spread rapidly. *Turnips*—A fair crop, although not equal to last year; about 15 tons per acre, and much the same quality as last year. The crop brairded slowly owing to the cold weather; little or no resowing required. *Insects*—No damage from insect pests. *Weeds*—No injury from weeds. *Pastures* showed good growth during the season, and would compare favourably with last year as regards quantity and quality. *Live Stock* throve well notwithstanding the excess of rain in spring and autumn, and came to the autumn sales in good order and sold well. Cattle and sheep free from disease. *Clip of wool* was a full average, although a little under last year, and of good quality.

KIRKCUDBRIGHTSHIRE. *Wheat*—None grown. *Barley*—None grown. *Oats*—A good crop of grain and straw, 25 to 40 per cent heavier than last year; about 55 bushels; 4 bushels seed sown. *Harvest* about 10 days later than usual. *Hay*—A very heavy crop of ryegrass and clover mixture; about 45 cwt. per acre. *Meadow-hay*—A heavy crop, but not above last year. *Potatoes*—Early varieties a very heavy crop, raised without disease. Late crops good, but partially diseased; disease showed early in August on the leaf; of new varieties a considerable acreage of "Great Scot" and Arran Chief" planted. *Turnips*—An excellent crop; brairded well and no resowing. Insect pests less than usual. No weeds. *Pastures* of average growth and quality. *Live Stock*—Stock did well. Cattle and sheep free from disease.

WIGTOWNSHIRE. *Wheat*—Only about 150 acres grown in the county. From 35 to 40 bushels; grain fair; straw very good; 4 bushels sown per acre. *Barley*—About 40 bushels; grain moderate quality; straw light. *Oats*—35 to 38 bushels per acre; quality of grain not so good as last year; smaller in pickle and more light corn; seeding, 4 bushels with drill and 6 bushels with hand. The wet cold weather during the first twelve days of April, and again during the first half of May, soured the land and stopped the growth of oats, from which they never recovered. *Harvest*—The harvest began about September 1st and ended about 26th; much the same as last year. Possibly one-tenth were caught with wet weather and did not get a portion of their harvest in for weeks. *Hay*—From 35 to 38 cwt. per acre; a fine crop and got in good order; nearly double of last year. *Meadow-hay* much more productive than last year; a very fine crop. *Potatoes*—From 3½ to 4 tons per acre; about half of last year. Not much disease, but softness of tubers in many cases caused by continued wet weather. No new varieties. *Turnips*—Supposed to be about 14 tons, but did not lift nearly as much as was expected. Quality not so good as last year; brairded fairly well. *Insects*—Nothing to complain of. *Weeds*—Spurry did a lot of damage to the grain crop as it came up, and choked the growth when the oats were water-logged. *Pastures*—The pastures were the best seen for many years—far above an average of years during the whole season. *Live Stock*—Stock seemed to thrive quite well on them, but dairy cows did not milk any better, if as well as usual. Cattle and sheep free from disease. *Clip of wool*—Quality of wool good; clip about an average.

GLASGOW DISTRICT.

AYRSHIRE. *Wheat*—50½ bushels per acre; quality of grain and straw average; 3 bushels seed per acre. *Barley*—41½ bushels per acre; quality of grain and straw fair; 3 bushels seed per acre. *Oats*—46 bushels per acre. Quality of grain and straw average where harvested before the end of September, otherwise very poor; 5 to 6 bushels seed per acre. *Harvest* about the usual time. Weather was fairly suitable up till the end of September, after which date it was hardly possible to do anything towards securing the grain till very late in November. *Hay*—1 ton 17½ cwt. per acre. *Meadow-hay*—1 ton 17 cwt. per acre. *Potatoes*—6 tons 15 cwt. per acre. A very little disease towards the end of July. No new varieties. *Turnips*—20 tons per acre; braird good; very little resowing. *Insects*—Not to any extent *Weeds*—Nothing more than usual. *Pastures* were not generally, except on the lighter soils, of average growth and quality with last year. *Live Stock* did not thrive so well as in some former years. Cattle and sheep free from disease. *Clip of wool*—About average.

BUTE. *Wheat*—None grown. *Barley*—Very little grown; an average crop, and well got; 4 bushels sown. *Oats*—Crop above an average; 44 bushels. The great bulk of the crop was got into the stackyard in fine order, but rain coming on greatly protracted the harvest, and the latter part was got in in very bad order; 5 bushels sown. *Harvest*—Rather a late harvest—about two weeks later than usual. Cutting of barley commenced during last week of August, and oats during first week of September. *Hay*—About an average; well got; about 2 tons 5 cwt. *Meadow-hay*—A very little grown, but a good crop; 2½ tons per acre. *Potatoes*—Digging began latter end of June; a good crop; an average of 9 tons per acre, very little disease. The late potatoes were not good;

about 7 tons per acre, with some disease. No new varieties planted. *Turnips* — From 20 to 30 tons per acre; brairded well; no second sowing; very few weeds. No insects, but great damage done by sparrows. No injury from weeds. *Pastures* above an average. *Live Stock* did well. Cattle and sheep free from disease. *Clip of wool*—Average, and good quality, and weighed well.

ARRAN. *Wheat*—None grown. *Barley*—Very little; fair crop. *Oats*—Plenty of straw; grain not so good; return about 30 bushels; seed sown from 5 to 6 bushels; part of the crop damaged at the end of harvest by heavy rains. *Harvest* a week later than 1915. *Hay* above average—1 ton 6 cwt. per acre; quality fair; not so much clover as previous year. *Meadow-hay*—Little grown; average crop; well got when cut early. *Potatoes*—About 6 tons per acre; as good as 1915; "Arran Chief" on strong land extra good; very little disease; no other new variety I know of; July digging turned out well. *Turnips*—Below average—say about 12 tons where sown in time; a good deal of finger-and-toe; early sown brairded well; late, rather poor. Insects not bad—about usual. No complaint of injury by weeds. *Pastures* rather softer; did not feed quite so well as previous year. *Live Stock*—Fairly well, but not equal to 1915. Cattle and sheep free from disease; foot-rot in sheep more prevalent. *Clip of wool*—The quality was barely as good as last year; less than average weight.

LANARKSHIRE (Upper Ward). *Wheat*—None grown. *Barley*—None grown. *Oats*—35 to 40 bushels; good quality, but did not ripen very evenly; 5 to 6 bushels sown. *Harvest* started first week of September, general second week; weather broke beginning of October, and all standing out then rendered almost useless by continual rain. *Hay*—2 tons per acre; good quality, well got. *Meadow-hay*—Much the same as last year; not so well got as the ryegrass. *Potatoes*—Less than last year; from 3 to 10 tons; not much disease; no new varieties. *Turnips*—20 to 25 tons; crop brairded fairly well, and no resowing. No injury by insects or weeds. *Pastures*—Better than last year. *Live Stock* did well. Cattle and sheep free from disease. *Clip of wool*—Good average.

LANARKSHIRE (Middle Ward). *Wheat*—The autumn weather during 1915 was unfavourable for the sowing of wheat on heavy lands, and the wet spring and summer were altogether against heavy crops in this area. There was an average amount of straw, but the grain was deficient in quality in comparison with ordinary seasons, and part of the grain was sprouted and only suitable for cattle food. Grain, 25 to 35 bushels; straw, 30 to 40 cwt.; seed sown, 4 bushels per acre. *Barley*—None grown. *Oats*—Where oats were sown early the crop was bulky, and on the whole is threshing out well per acre. Part of the crop was damaged by rain in the higher districts. Grain was of medium quality. Grain, 40 to 60 bushels; straw, 30 to 40 cwt.; seed sown, 5½ to 6 bushels. *Hay*—Ryegrass and clover-hay were exceedingly heavy crops, but part of the crop was weathered and poor in quality. Weight, from 35 cwt. to 3 tons per acre. Prices in July and August from £4, 12s. 6d. to £5 per ton. *Meadow-hay*—Timothy hay was also an exceedingly heavy crop, and gave from 2 to 3½ tons per acre. *Potatoes*—The wet spring was very unsuitable for the braird and growth of potatoes. Part of the seeds seemed to decay, leaving a very uneven braird. The crop gave the smallest yield on record, some fields yielding little more than the quantity of seed required for planting. The average yield per acre was from 1 ton to 8 tons per acre. *Turnips*—The turnip crop was under the average, but

remained healthy. The yield would be from 5 to 20 tons per acre. *Pasture* was very abundant all season. *Live Stock*—Stores and fat stock have been exceptionally high in price, and the cattle have been very free from any disease. *Clip of wool*—There are no sheep in this ward.

LANARKSHIRE (Lower Ward). *Wheat*—Crop variable; 35 to 40 bushels; quality very fair; straw quite an average; 4 bushels seed. *Barley*—Only limited quantities sown. *Oats*—50 to 60 bushels; quality variable; straw, 30 to 40 cwt.; also variable in quality; 6 bushels sown. *Harvest* about the usual time; weather conditions delayed finish. *Hay*—Quite a full average—30 to 40 cwt.; fair quality. No meadow-hay grown. *Potatoes*—Very small crop generally. *Turnips*—Also small crop—about 10 tons. No injury by insects; injury by pigeons greater than usual. No injury from weeds. *Pastures*—Full average. *Live Stock* did well. Cattle and sheep free from disease. No clip of wool.

RENFREWSHIRE. *Wheat*—40 bushels per acre; more straw than usual, and of good quality—fully 2 tons average to the acre; 4 bushels seed per acre. *Barley*—None grown to reckon with. *Oats*—54 bushels per acre; more straw than usual; average, say 35 cwt. to the acre; 5 bushels seed per acre. *Harvest* began about average of seasons. Very good harvest, except in the higher and late districts, where much grain, damaged owing to continuous wet weather; some got caught by bad weather, and from want of labour were kept back with harvest. *Hay*—Very good crop; better than last year, both ryegrass and clover; average crop in lower districts, say 2 tons 10 cwt. *Meadow-hay*—Not much meadow-hay grown, but this quite a good crop, and above the average both as regards quantity and quality. *Potatoes*—In most cases poor returns; 4 tons 10 cwt. to 5 tons fair average; much less than last year; no disease to speak of; no new varieties planted different from last year. *Turnips*—Good average crop; fully heavier than last year, say 25 tons per acre on good land; no second sowing to speak of. No damage by insects or weeds. *Pastures*—Very abundant and of good quality. *Live Stock* did well. Cattle and sheep free from disease. *Clip of wool* quite up to average.

ARGYLLSHIRE (Lochgilphead). *Wheat*—None grown. *Barley*—None grown. *Oats*—Not so good as last year—say 5 quarters; straw much less; quality of both fairly good; seed sown, about 5 bushels. *Harvest*—A few days later—about 30th August; good weather for those who were early. *Hay*—Ryegrass hay in most cases a poor crop, but where well done and early saved very good; from 1½ to 2½ tons per acre. *Meadow-hay*—Much the same as last year; well got where not too late. *Potatoes*—Potato crop poor—possibly about 4 to 5 tons per acre, and in some cases less; a good deal of disease; "Arran Chief" seemed to do best. *Turnips*—Turnip crop not more than last year; from 15 to 18 tons per acre; grew very much to neck, and were very disappointing when it came to pulling time. *Insects*—No injury by insects. *Weeds*—Not much injured by weeds, except thistles, which seem to get very prevalent. *Pastures* very rough, but not of such good quality owing to too much wet. *Live Stock*—Not so well as in a drier season. Cattle and sheep free from disease. *Clip of wool*—Quality of wool very good, but not quite up to the average weight.

ARGYLLSHIRE (Kintyre). *Wheat*—None grown. *Barley*—Not so good as last year; about 40 to 45 bushels; fairly well harvested. *Oats*—Not so good as last year; from 5 to 6 quarters; straw also shorter;

5 bushels seed per acre. *Harvest* about the usual time. *Hay*—Rye-grass barely as good as last year; well got; about 2 tons to the acre. *Meadow-hay*—About the same as last year. *Potatoes*—Not nearly so good; not much disease, but a middling crop both early and late. *Turnips*—From 15 to 20 tons; brairded well, but a lot was late in being sown owing to the wet spring. Not much injury by insects. No damage by weeds. *Pastures* rather better than last year; quite an average. *Live Stock* throve quite well. Cattle and sheep free from disease; braxy less than last year. *Clip of wool*—Quite an average.

ARGYLLSHIRE (Islands of Islay, Jura, and Colonsay). *Wheat*—None grown. *Barley*—Practically none grown. *Oats*—Very much lighter than last year; owing to stormy weather a great deal of grain was lost in the field. *Harvest*—About ten days later than usual. *Hay*—Good average crop. *Meadow-hay*—Similar to last year. *Potatoes*—The crop was a much poorer one than last year; disease did not exist to any great extent; the yield was poor; no new varieties. *Turnips*—The crop at the beginning of the season appeared average, but turned out lighter than the average, the yield being considerably less than last year. *Insects*—No damage was done by insects or weeds *Pastures*—Average growth and quality of last year. *Live Stock* throve exceedingly well. Cattle and sheep free from disease. *Clip of wool*—Good; about an average.

STIRLING DISTRICT.

DUMBARTONSHIRE (Upper). *Wheat*—None grown. *Barley*—None grown. *Oats*—Oats were generally a fair crop, and where early were well got, but some fields were practically lost by wet weather in the beginning of October, and continuing; grain, about 32 bushels per acre; 5 to 6 bushels sown. *Harvest* began about the usual time—last week of August—but lasted till December. *Hay* was fully heavier than last year, and was well got; about $1\frac{3}{4}$ tons per acre. *Meadow-hay* was considerably heavier than last year, and was saved in good order. *Potatoes* were a very poor crop; from 2 to 5 tons per acre; there was a little disease, but not much. *Turnips*—Rather lighter than last year; about 18 tons per acre; brairded well; no resowing. *Insects*—Not a great deal of damage; there was a little grub in lea oats, but not much. No damage by weeds. *Pastures* were very slow in coming forward, but afterwards were very good. *Live Stock* throve well. Cattle and sheep free from disease. *Clip of wool* was rather under the average, both in quality and weight.

DUMBARTONSHIRE (Lower). *Wheat*—Not much grown in district; seed from 3 to 4 bushels. *Barley*—Very little, if any, grown. *Oats*—More straw than last year, and less grain; badly laid and difficult to cut; seed from 5 to 6 bushels, according to variety and soil. *Harvest* a few days later than usual; good harvest weather till beginning of October; after 3rd October, what was got in was in a more or less damaged condition. *Hay*—A heavier crop than last year; about 2 tons, and well got; quality softer than last year. *Meadow Hay*—Heavier than last year. *Potatoes*—Lighter than last year; early varieties from 6 to 7 tons; "Maincrops" not over 4 tons on an average. The principal reason for the small crop was the bad seed bed. *Turnips*—Lighter than last year; brairded fairly well; rather later in sowing than usual owing to wet weather. No injury by insects or weeds. *Pastures* of average growth and quality. *Live Stock* throve very well. Cattle and sheep free from disease.

STIRLINGSHIRE (Western District). *Wheat*—Little grown hitherto, but tried in several additional instances with more or less satisfactory results. Yield, about 38 bushels; grain and straw of fairly good quality; seed, 4 bushels. *Barley*—None grown. *Oats*—Average yield, 40 bushels. Where crop secured by first week in October grain and straw of good quality. Unfortunately a large proportion of the crop was not then harvested, and suffered severely from exposure to the unfavourable weather which set in and continued till near the end of November. Seed, 5 bushels. *Harvest* began about 4th September, being a few days later than last year. *Hay*—2 tons per acre, which was a decided improvement upon the yield of last year. The usual proportion of clover was present, and the crop was well got. *Meadow-hay*—In this case the production was similar to last year, and also well secured. *Potatoes*—Around 4 tons per acre, or half the usual crop. Free of disease at raising, but, owing to the wet weather then prevailing, did not keep well in the pits. No new varieties planted. *Turnips*—Twenty tons per acre of average quality. Somewhat long in brairding. Only one sowing. No damage from insects. *Weeds*—Crop injured by redshank to the usual extent. *Pastures*—Over average growth and quality. *Live Stock* throve very well. Cattle and sheep free from disease. *Clip of wool*—Up to the average both as regards quality and clip.

STIRLINGSHIRE (Eastern District). *Wheat*—44 bushels; good quality of grain and straw; seed, 3 bushels. *Barley*—30 bushels; grain of good quality; straw fairly good; seed, 3½ bushels. *Oats*—31 bushels; fair average crop; straw rather short; seed, 4 bushels. *Harvest*—Usual time; early harvest well done; late districts bad weather. *Hay*—An average crop, well secured; on carse, 40 cwt.; dryfield, 30 cwt. *Meadow-hay*—Big crop—not well got. *Potatoes*—Some districts good crop—others very bad; 5 tons per acre; some disease. *Turnips*—20 tons—poor crop; brairded well; no second sowing; on clay land a poor crop—too late in sowing. No damage by insects. *Weeds*—Crops injured by mustard and thistles. *Pastures*—Average year. *Live Stock* throve fairly well. Cattle and sheep free from disease. *Clip of wool*—Just about an average.

Note.—The war has taken away too much labour from the land, and farms as a whole have not got the same attention.

CLACKMANNANSHIRE. *Wheat*—Owing to unfavourable weather at sowing time a less area was sown. The yield is under the average both in grain and straw; 30 to 40 bushels per acre; 3 to 4 bushels sown. *Barley*—A less breadth sown, under very unfavourable conditions, consequently a poor crop—much under the average in bulk and quality; it is difficult to estimate the yield per acre, the crop being so unequal; 3½ to 4 bushels sown. *Oats*—A poor crop—nearly a half under the average; short in grain and much shorter in straw. In late districts the crop was much destroyed in harvesting owing to wet weather; 4 to 5 bushels sown. *Harvest*—The harvest was about a fortnight later in commencing than last year. At the beginning there was wet weather, then a period of good harvest weather, after which rainy weather set in, doing much damage to the crops not then secured. *Hay*—This was a fair average crop; it was rather difficult to secure at the end of the hay harvest owing to broken weather; 1¾ to 2 tons per acre. *Meadow-hay*—A fair good average crop, and where early cut was well got, and would be a third better than last year. *Potatoes*—One of the worst crops as to bulk, size, and quality grown for many years; not nearly a half average crop, and much worse than last year; the tubers were smaller, with a

good deal of disease. The yield varied so much in different districts that it is difficult to estimate. *Turnips*—This crop was little if any above half the average, and was worse than last year. *Insects*—There was little or no damage by insects to crops; maggot fly on sheep was troublesome to a later period than usual. *Weeds* were worse than usual. Owing to continuous wet weather they could not be kept down where the farm staff was short-handed; soft weeds in the green-crop break were the worst. *Pastures*—As the grass had an abundance of moisture nearly the whole season through there was a good crop, but softer than usual. It got firmer as the season went on. *Live Stock*—At the beginning of the season, which was colder than usual, cattle did not do well on the grass, but as the season advanced it got drier, and stock improved. No disease in stock, except foot-rot in sheep, which was troublesome. *Clip of wool*—The quality of the wool was a little under last year, but the bulk was a full average.

PERTHSHIRE (Western District). *Wheat*—Under the average both with respect to grain and straw; 36 bushels; seed, 3 to 3½ bushels. The area of wheat grown would be rather less than the previous year; crop in good condition. *Barley*—Crop was under the average, but the quality of grain was above an average; straw was under the usual bulk—about 30 bushels per acre; seed, 4 bushels. *Oats*—A fair average crop, but straw was not up to the usual bulk of some former years; the yield of grain is much under the average—about 32 to 36 bushels per acre; seed, 4 to 4½ bushels per acre. In some of the later districts the crop was not secured in good condition, but in most districts it was well got. *Harvest*—About same time as the previous year, and generally was of short duration, but the weather broke down before the crops had been secured on some farms. *Hay* crops generally suffered from unfavourable weather early in the year, and never having recovered, the crops were under an average, and the quality barely an average. *Meadow-hay*—Deficient in bulk but good in quality. *Potatoes*—Very poor crops; in many cases not more than 1½ to 2 tons of marketable tubers per acre. In some cases the crop is dressing out more seed than otherwise. *Turnips*—Only a fair crop on good land, and, generally speaking, the bulk was from 4 to 6 tons per acre under the average; crop brairded well. *Insects*—Nothing to speak of. *Weeds*—Crops uninjured; the dry weather helped the destruction of any weeds. *Pastures*—Not quite of average growth, as the cold spring told severely on first and second years' grass, and these never recovered during the summer. *Live Stock* throve fairly well on good pastures, but in many cases they did not leave much for grazing if purchased during the spring. Cattle and sheep free from disease. *Clip of wool*—About an average generally, though on many farms the clip would not be quite an average. Ewes had a bad time on hill farms last spring.

PERTH DISTRICT.

FIFESHIRE (Middle and Eastern District). *Wheat*—It is generally agreed that the crop has threshed out under the average, owing to the unfavourable weather retarding the development of the ear; the yield would be from 26 to 32 bushels grain, with from 25 to 30 cwt. straw of good quality per acre—the usual seeding is from 3½ to 4 bushels per acre. *Barley*—Would be about an average, yielding from 35 to 44 bushels per acre; a much superior crop to last year. Straw a full average; seed

sown from 3½ to 4 bushels per acre. *Oats*—An average crop of fine quality, yielding from 54 to 56 bushels per acre; some of the new regenerated varieties possibly yielded more; abundant straw of good quality; seed from 5 to 6 bushels per acre. *Harvest* was general on 1st September, and was quickly overtaken in about one month, resulting in all grain being stacked in good condition. *Hay*—There was an excellent and bulky crop of hay of good quality, yielding about 2½ tons per acre, and coled in good order; compared with last year it was of much superior quality. *Meadow-hay* is relatively negligible—very little being grown; the wet weather in the autumn destroyed much of it. *Potatoes* were a disappointing crop on many farms in quantity and quality; possibly the smallest crop in any one's remembrance, yielding from 1½ to 4 tons immature tubers, the latter return being got only from soil suited to the season, and from such varieties as "Arran Chief" and "President"; soft varieties were much diseased. *Turnips* were also a disappointing crop, never reaching to full development, and yielding a poor return of from 7 to 15 tons per acre; little or none were stored owing to lateness and labour scarcity; much loss resulted from frost and disease and rot; there was no resowing. *Insects*—The crops were not injured this year by insects. *Weeds*—Except on land which was flooded in the autumn there was not much trouble with weeds. *Pastures*—The pastures were of average growth and quality. *Live Stock* throve well. Except some cases of "Anthrax" and "Wooden Tongue" there was no disease in cattle or sheep. *Clip of Wool*—The quality and weight of wool would be less than last year, and under the average.'

FIFESHIRE (Western District). *Wheat*—The crop would be an average, yielding 30 to 36 bushels per acre, with straw of average quality; some damage was caused by sprouting in the case of late harvested wheat; seeding, 3½ to 4 bushels per acre. *Barley*—The barley crop may also be estimated at 30 to 36 bushels, and a good average crop of straw; on barley land, after sheep, much of the straw was wasted by excessive rains; 3½ to 4 bushels seed per acre. *Oats*, like the previous year, were the crop of the season; on the best lands the yield would be 48 to 56 bushels per acre, while the straw would be over an average; as with barley, on wet and late farms some of the oats were poor, due to the wet and cold spring; 4 to 6 bushels seeding when sown broadcast. *Harvest* was about two weeks later than usual in starting, and was troublesome, due to scarcity of labour and unfavourable weather conditions. *Hay*, unlike crop of 1915, was good, and a good turn of weather was got to harvest it; average yield, 2 to 2½ tons; where hay had been heavily top-dressed the ryegrass showed signs of ground rot; second cutting was mostly destroyed by wet weather. *Meadow-hay* was also a heavy crop, and secured in good condition. *Potatoes*—The poorest crop raised for many years; "Arran Chief" and "King Edward" are dressing about 3 tons seed and ware per acre; "Golden Wonder" is estimated at 1 to 1½ tons per acre; practically no disease is reported with the newer varieties. *Turnips*, like potatoes, are a short crop; estimated at half an average crop, and in many cases at even less on late farms; the seed brairded well, but the young plants suffered severely during the dry weather in July; no reports of second sowing. *Insects*—Crops were free from insect pests. *Weeds*—Annual weeds caused trouble among turnips on farms where labour was scarce; otherwise crops were free from weeds. *Pastures*—There was abundance of grass during the grazing season, and of good feeding quality. *Live Stock*—All classes of stock throve well on the pastures. Cattle and sheep free from disease. *Clip of wool* an average, and of good quality.

PERTHSHIRE (Eastern District). *Wheat*—Not so heavy as last year; rather thin in places, but good quality; yield, about 34 bushels; seed, 3 to 4 bushels. *Barley*—A fair crop of fair quality; yield, about 32 bushels; seed, 3 to 4 bushels. *Oats*—A bulky crop, but not threshing well; good quality where secured early; yield, about 44 bushels; seed, 4 to 6 bushels. *Harvest* about ten days later than usual. *Hay*—A very good crop, and secured mostly in excellent condition; yield, about 2 tons per acre. *Meadow-hay* much heavier. *Potatoes*—The worst crop on record; yield, 3 to 4 tons per acre, with about ½ diseased; "Arran Chief" and "Evergood" did best. *Turnips*—A light crop, but sound and of good quality; yield, 17 to 18 tons per acre; very little second sowing required. *Insects*—Crops not injured more than usual. *Weeds* of all kinds throve exceedingly, due to the wet season and scarcity of labour. *Pastures* grew rather too luxuriantly, and got rough in the latter part of season. *Live Stock* throve well. Cattle and sheep free from disease. *Clip of wool*—Rather under average.

PERTHSHIRE (Central District). *Wheat*—The acreage in wheat last year was rather under the previous year. The cause of this was the shortage of labour and the wet November and December of 1915. The straw was of very good quality and bulky. The sample was good, but if anything the grain was on the small side. As a rule, 4 bushels were sown to the acre, and the yield was about 32 bushels to the acre. *Barley*—This was a fair crop, and the sample was very fine. The quantity sown would be from 4 to 5 bushels per acre, and the yield would average 34 bushels to the acre. *Oats*—The area of oats sown would be very much more than the previous two years, and the yield would be from 38 to 45 bushels to the acre. The seed sown would be from 4 to 5 bushels to the acre. On most of the farms the farmers have seed-drills, and a great saving in seed is the result. *Harvest*—The harvest was a fickle one. Those who were able to secure their crops during the last week of August and the first 3½ weeks of September were lucky. The weather broke down about the end of September, and for 5 weeks rain fell every day, the result being that the farmers who were caught had a bad harvest. *Hay* was, on the whole, a bulky crop, and was secured in very good condition. The quantity per acre would be from 30 to 45 cwt. In one field near Forteviot, close to the river Earn, the hay is still in small ricks—20th January 1917. It seems to be very black. *Meadow-hay*—The crop of meadow-hay was a heavy one, yielding from 25 to 35 cwt. per acre. *Potatoes*—The potato crop of 1916 is the worst we have had for many years. The area planted was an average one, but the yield was very disappointing. A few lots of early potatoes turned out fair, but, as a rule, the medium and late varieties were a small crop. There was practically no disease. It is difficult to give the yield. The varieties planted in the district were "British Queens," "Dates," "Dalhousies," "Arran Chiefs," "What's Wanted," "Langworthies," &c. *Turnips*—The acreage in turnips was about the same as last year, but the crop is just about one-half. On account of the wet spring the land could not be worked, the result being that the turnips did not develop. On some farms finger-and-toe was reported. *Weeds*—Turnip crop was injured by weeds, due to want of labour. *Pastures*—The pastures during the past year were normal. *Live Stock*—The stock, as a rule, did very well on the pasture land. On account of the moisture there was very little grass scorching. Cattle and sheep free from disease. *Clip of wool*—The wool clip was an average, and the price allowed was a paying one.

PERTHSHIRE (Highland District). *Wheat*—None sown. *Barley*—Practically none sown last year. *Oats*—An average crop; fairly good in

grain, and weight good per bushel, but the quantity under the average; 36 bushels; 6 bushels seed per acre. *Harvest* began a week later than the usual, but as the crops ripened fast and the weather was fine, it took less time than in the average of years. Labour had been very scarce, but so many soldiers having been liberated for harvest work helped greatly. *Hay*—A much heavier crop than last year, and a good mixture, and all well got; about 2 tons. *Meadow-hay*—Much the same as last year; late, difficult to secure, and not of an average quality. *Potatoes*—A very disappointing crop; plenty tubers to the shaw, but undersized and without any ware; 1½ tons. *Turnips*—About 8 tons; quality and quantity much less than last year. The crop brairded well, and came very fast to the hoe, with plenty of tops, but failed to bulb; not nearly an average crop; no second sowing required. No damage done by insects or fly. *Weeds*—The crops throughout fairly clean, and less damage than usual. *Pastures*—The pastures were up to the average in growth, and stood out well in autumn. *Live Stock*—The stock did well all summer. Cattle and sheep free from disease. *Clip of wool*—The quality of the wool was not up to the average, and the bulk much less than average; no doubt caused by the long and severe winter and so much hand-feeding required.

FORFARSHIRE (Western District). *Wheat*—35 to 37 bushels, with a fair quantity of straw; seed, 3 to 3½ bushels drilled; 4 bushels broadcast. *Barley*—36 to 38 bushels, with plenty of straw—some on soft land badly laid; seed, 3 to 3¾ bushels drilled; 4 to 4½ broadcast. *Oats*—44 to 48 bushels, with abundance of straw. Many fields of lea oats badly laid, and much damage done. Owing to continued wet and close weather, a few fields were still uncut at 1st January; seed, 3 to 5 bushels drilled; 4 to 6 bushels broadcast—according to variety. *Harvest* commenced a little later than usual; fairly suitable weather till beginning of October, and much grain stacked in excellent condition. From this time lying grain could not be cut dry, and leading was much retarded. Five inches of rain fell in seventeen days from 3rd October to end of month. *Hay*—The hay crop was an excellent one—36 to 40 cwt. (in many instances more), and generally secured in good order. *Meadow-hay*—Very little meadow-hay, but also a good crop. *Potatoes*—The potato crop was in many instances almost a total failure; 6 tons is the exception; 3½ to 4 tons about the average. Many fields would not produce more than 2 tons an acre, and some not worth lifting. There was a good deal of disease. One night's frost did some damage. *Turnips*—A poor crop; 25 tons the exception, many acres of good land producing only 14 to 16 tons. *Insects*—There was little injury by insects. *Weeds* abundant, especially in turnip crop, where horse work could hardly be done owing to wet. *Pastures*—Plenty of grass generally, and abundance of foggage in the "back-end." *Live Stock* did not do so well as usual. Cattle and sheep free from disease. *Clip of wool*—A full average.

ABERDEEN DISTRICT.

FORFARSHIRE (Eastern District). *Wheat*—34 bushels grain, and about 32 cwt. straw, both of very good quality, but grain light in weight. Seed as usual, about 3½ to 4½ bushels per acre. *Barley*—A poor threshing crop; anything from 24 to 36 bushels, and about 23 cwt. straw. Much of the grain poor quality as well as a poor yield; season not suitable for good barley either in colour or quality. Seed, 3 bushels drilled in, 4 bushels broadcast. *Oats*—Yield under the average—48 bushels per acre; plenty

of straw; about 26 cwt. per acre; grain good quality, straw coarse and poor feeding. Seed, new thick-skinned varieties, 6 bushels per acre, usually now sown 3 bushels each way; other varieties, 4 bushels per acre. *Harvest* commenced about 5th September, 10 days later than usual, and finished middle of October; all harvested in October was more or less in bad order. *Hay*—A very heavy crop, more than twice last year's, and from about 60 to 70 cwt. per acre; quality generally good, with plenty of clover, but in some places overgrown and coarse. *Potatoes*—The poorest crop on record, many farms not exceeding about 30 cwt. per acre; a very few places up to 5 or 6 tons. No disease in "Presidents" and "Northern Star" varieties, but "King Edwards" and "Arran Chief" some disease, and not well kept in pits. No new varieties to any extent. *Turnip* crop generally very poor—12 to 20 tons per acre. Crop brairded all right, but greatly damaged by excessive rains at thinning time. No injury by insects. *Weeds* of all kinds rampant, neither hand nor horse labour being permissible on account of wet weather. *Pastures*—Plenty of pasture everywhere. *Live Stock*—Too much rain for stock doing as well as usual, although grass was everywhere abundant. Cattle and sheep free from disease. *Clip of wool*—Fair, of just under average weight.

KINCARDINESHIRE. *Wheat*—Not up to last year's crop; from 36 to 39 bushels grain per acre, of fair quality, and plenty of straw; 3 bushels seed per acre where drilled, and 4 bushels broadcast. *Barley*—Slightly under last year's crop; 36 bushels grain and 17 cwt. straw, both of fair quality; 3 bushels seed drilled, and 4 bushels broadcast. *Oats*—Not quite an average crop; from 39 to 42 bushels grain, and 17 cwt. straw, both fair quality; 4½ bushels seed where drilled, and 5½ broadcast. *Harvest*—Nearly three weeks later than last year, and in the later districts very much protracted; extreme difficulty in getting in the balance of the crop owing to the continued wet weather. *Hay*—The crop of rye-grass and clover hay was quite a good one—much better that the previous year—and was generally secured in good condition. Average weight about 33 cwt. per acre. The aftermath was rather poor generally owing to cold weather. *Meadow-hay*—Almost none in the district, consequently no reliable information can be given as to crop *Potatoes*—The potato crop was the poorest for many years—in fact, almost a failure in several districts, largely due to the continued cold wet season. *Turnips*—The turnip crop was much under that of last year, and much under the average for Kincardineshire; the amount of crop varied considerably in different districts, hence difficulty in fixing the average yield per acre. *Insects*—Very little injury done by insects, it being far too cold and wet for damage to result from this cause. *Weeds* were rather difficult to manage owing to continued wet weather, and much hoeing and harrowing were required, surface weeds being very abundant. *Pastures* were of average growth and quality, quite as good if not more plentiful than last year, but grass did not grow so well during the later part of the season. *Live Stock*—Stock generally did fairly well on the pastures, but butchers complained that fat cattle did not weigh so well as in normal seasons. Cattle and sheep have been fairly free from disease, although a few cases of anthrax have occurred amongst cattle, as well as some other minor troubles. *Clip of wool* was fairly good, but slightly under last year's average both in quality and quantity.

ABERDEENSHIRE (Buchan District). *Wheat*—None grown. *Barley*—Extent of this crop somewhat restricted; quantity per acre rather under the average, with less weight per bushel—52 to 56 lb.; seed sown, about

4 bushels. *Oats*—A wet and late seed time, with a combination of rainy weather and a summer unfavourable for ripening of crops made the oat crop very much below that of 1915 in quantity and quality; this crop threshed out very badly; straw is also very short of an average yield; weight of oats from 37 to 40 lb. per bushel. *Harvest* commenced towards end of September; as the weather broke before the crop was all secured (except in a few early farms), and continued to be wet, the harvest was a very protracted one. *Hay*—The hay crop was the only good crop of 1916, and was above the average. It was secured in very good order—about 28 to 35 cwt. per acre. *Meadow-hay*—Very little grown in this district. *Potatoes*—The worst crop for many years; not much disease, however. *Turnips*—Turnips turned out a very poor crop all over; the turnips sown before Whitsunday have become very much "shot." It would be difficult to fix the general average as to weight per acre; the crop brairded fairly well, with little resowing necessary; also free from disease on the whole. No injury by insects. *Weeds* more plentiful than usual owing to continuous wet weather. *Pastures* were up to an average growth, especially during the early season. *Live Stock* throve fairly well on pastures. Cattle and sheep free from disease. *Clip of wool* on the whole above the average.

ABERDEENSHIRE (Central District). *Wheat*—None grown. *Barley*—27 bushel per acre; 5 bushels less than last year; straw 19½ cwt. per acre; 1½ cwt. less than last year. Quality of the grain not so good as last year, which was under an average; the quality of the straw would be equal to last year's. Weight of grain per bushel varied from 48 to 56 lb., a large proportion ranging from 52 to 53 lb. Seed used—drill machine, 3 to 3½ bushels per acre; broadcast machine, 4 bushels per acre. *Oats*—35 bushels per acre; 5 bushels less than last year; straw, 21½ cwt.; 1½ cwt. less than last year. Quality of grain not so good as last year; the quality of straw similar to last year. Weight of grain per bushel ranging from 37 to 45 lb.; a large proportion ranging from 40 to 41 lb. Seed, potato oats, and all thin-husked varieties where drill machine used, 4½ to 5 bushels per acre; broadcast machine, 6 to 6½ bushels per acre; all thick-husked varieties 2 to 2½ bushels extra per acre. In both barley and oats there is more than a usual proportion of small and undeveloped grain. *Harvest* commenced about the 10th September—about same time as last year, and barley was mostly cut and secured before the end of the month. About 7th October a good proportion of all grain crops was secured on the earlier farms; on later farms a good deal was still to secure under very unfavourable conditions. Frost on the 17th October damaged all uncut and green crops; with a few exceptions all was secured in varying condition about the 27th—fully a fortnight later than last year. *Hay*—Average 38 cwt. per acre—10 cwt. more than last year. The crop was well mixed with clover, and quality very good where secured in good condition. *Meadow-hay*—Average 31 cwt. per acre; 10 cwt. more than last year. *Potatoes*—Average 5 tons per acre; 2½ tons less than last year. Quality not so good as last year. A good many cases of disease were reported from September onwards to lifting. No report of new varieties being planted. "Arran Chief," "Main Crop," "Dalhousies" principal varieties planted. To the very wet season during planting and earlier stages of growth is attributed the very poor crop. *Turnips*—14 tons per acre; 5½ tons less than last year; quality very varied. Very few turnips were sown in May, and on account of wet weather about half of the land intended for turnip crop had not been touched at end of May. Some abnormal crops of weeds were to be seen. Despite the unfavourable sowing conditions,

the crop brairded fairly well, not more than one sowing being required. Some fields intended for turnips, on account of very unfavourable weather conditions, were never sown. *Insects*—No complaints of injury by insects. *Weeds*—Owing to the abnormally wet season, grain, potato, and turnip crops suffered from the extraordinary growth of weeds, especially on land flooded by water. Yarrow, chickweed, and small surface weeds grew in great abundance and choked the crops, damage in this respect being much greater than usual. *Pastures*—The pastures were of more than average growth, hay and pasture being the crops of the season. It is doubtful, however, if the feeding qualities were equal to last season. *Live Stock*—Fairly well on the whole ; young and growing animals did well, but were slow to feed. Cattle and sheep free from disease. *Clip of wool*—The quality was only fair, and under an average.

ABERDEENSHIRE (Strathbogie District). *Barley*—The acreage devoted to barley last year was less than in recent years. As regards straw, the crop bulked fairly well. The promise of grain, however, was only fair, and the results of threshing have been most disappointing ; indeed it has been the worst threshing crop for many years, the weight per bushel varying from 48 to 53 lb., and the yield ranging from 2½ to 3½ qrs. per acre. *Oats*—In proportion oats have been little better than barley, the return in grain ranging from 3 to 4 qrs. per acre, with a bushel-weight varying from 38 to 41 lb. The cold sunless season, with too heavy a rainfall, has been responsible for the unsatisfactory results. In the later parts of the district much damage was caused by a severe premature frost. *Harvest*—The commencement of harvest was generally about ten days later than an average season. The crops were light, and little difficulty was experienced with the reaping, but the weather during leading-time being uncertain, much of the crop was secured in only middling order. *Hay*—The hay crop generally was good, and the weather being fairly good during the curing season, the crop sustained little damage. There was generally a fair mixture of clover, and the crop has been good for feeding purposes. Perhaps 175 stones per acre may be given as an average for the district. *Meadow-hay*—There is no meadow-hay grown in this part of the country. *Potatoes*—The potato crop generally has been the worst for many years. In some cases this useful crop has been almost a failure, while in the best instances the yield has been little more than one-third of an average. The potato being a sun plant, no doubt suffered greatly from the absence of sunshine and the superabundance of moisture during the growing season. *Turnips*—Like the potato, the turnip crop has also been remarkably light—a long way below an average yield—so that roots are being used very economically in byres, where in former years there used to be plenty for the stock. There was no resowing required, and no disease in the district. No damage by insects. *Weeds*—The wet season was rather against the proper clearing of the turnip-break, but fortunately there was no superabundance of weeds. *Pastures*—During the season the pastures were of average growth, and during the early part stock throve remarkably well, but after the middle of the grazing season was reached the weather was greatly against stock of all kinds laying on flesh and fattening properly. Complaints were therefore heard on every hand of the slow progress that animals made during the end of the season. There has not been any disease among either cattle or sheep. *Clip of wool*—The general quality of the wool clip was up to an average. The cold weather experienced before shearing-time has always an effect on the weight of the clip on account of the absence of grease. The weight may therefore be considered as being below an average.

BANFFSHIRE (Lower District). *Wheat*—None grown. *Barley*—25 to 30 bushels per acre; quality below average owing to cold and wet spring, the weight being only from 51 to 54 lb. per bushel. The usual acreage was sown; seed, 3 to 4 bushels per acre. *Oats*—45 to 50 bushels per acre; quality was good, weighing from 42 to 46 lb.; the crop was well harvested, and the quality of the straw was also good; seed sown, from 5½ to 6 bushels per acre. *Harvest* began about the 1st September and finished about the middle of October. *Hay* was an excellent crop, secured in good condition; 2 to 2½ tons per acre, with an abundance of clover. *Meadow-hay*—None grown. *Potatoes*—Yield from 2 to 4 tons per acre (or less than half the usual crop), except in one or two special cases where the newer varieties, such as "Arran Chief," were grown; no disease. *Turnips*—Weight from 12 to 20 tons per acre; quality equal to last year, but the weight slightly under last year. They were sown late, and in very wet weather; the crop brairded all right, but did not make much progress until the autumn months. In exceptional cases, where sowing took place immediately before very heavy rain, the ground became *crusted* and second sowing was necessary. No damage by insects. *Weeds* were very plentiful—chiefly knot-grass, which seems to be very much on the increase in this district. *Pastures*—Above average. *Live Stock*—Stock did not do well in the early part owing to the exceptionally wet weather, but improved greatly during the autumn. Cattle and sheep free from disease. *Clip of wool*—The quality of the clip was good, and the quantity slightly above the average.

BANFFSHIRE (Upper District). *Wheat*—None grown. *Barley*—Happily the area under barley was restricted owing to the high price at seed-time; then the crop proved a comparative failure both in quantity and quality, scarcely any fields giving three-quarters, and that not fit for distilling. *Oats* after lea were a fair crop, but were rather late in being sown, and dragging in growth from the cold and wet, were improperly matured. In clean land never was such failures seen; then on good soils the yield did not come to qrs. per acre. *Harvest*—1916 will long be remembered as a most unfortunate season both as regards grain and straw, and in general only about half an average bulk, and all of inferior quality. Very little of the oats come to 40 lb. per bushel. The greater part was rendered unsafe for seed by a night's frost in September just as harvest was beginning. *Hay*—The hay crop was the one good item for the farmer; well mixed with clover and ryegrass, and might weigh between 2 and 3 tons per acre. The crop was generally secured in good order by the middle of August. *Meadow-hay*—Meadows are mostly pastured in this district when the sown grasses get bare between hands before the aftermath comes in use. *Potatoes* are only planted for the household. Much of the seed failed to sprout owing to wet, cold weather prevalent in June, and they are a poor crop except in dry sunny spots. *Turnips*—The turnip crop was a fearful toil in laying down—all except sloping fields which were stubble dunged; these came out well at first, but went early to seed, and the bulbs are now of little use. In other cases farmers held on laying down very late, and the results are miserably poor indeed. *Insects*—The wet and cold weather seems to have killed out the customary farm pests, including the turnip-fly. *Weeds* abound in the turnip fields, and grubbing and harrowing had no effect owing to the wet; knot-grass in particular was also more than usually prominent in corn-fields where the grain was thin. *Pastures* came out fairly well by the end of June, but fell off sooner from the cold and wet weather. *Live Stock*—All kinds of stock did well until fields got rather bare, but as prices were good, graziers cleared out to suit the keep.

Happily no disease to speak of. *Clip of wool*—The wool clip proved an average one. Complaints were rife that Government had struck rather too low price for wool, in view of the high prices for sheep and the large outlays in feeding materials.

Note.—The worst feature of the year 1916 is the poor crop returns in grain and roots, which affect the farmer's position in this upland region in an inordinate degree. Wages and all tear and wear are at higher rates, and no selling grain to meet such; much seed grain has to be procured at extreme rates for next season's crop.

INVERNESS DISTRICT.

MORAYSHIRE. *Wheat*—Very little grown. *Barley*—About 20 bushels per acre, or half previous year; straw about 30 cwt., or 6 cwt. less than last year; weight of grain about 54 lb., or 2 lb. under standard; colour good; seed sown, 3 to 4 bushels. *Oats*—30 bushels, or 18 bushels less than last year; straw about 35 cwt., or 8 cwt. less than last year; weight per bushel about 40 lb., or 2 lb. under standard; otherwise quality good; seed sown, 5 to 8 bushels, according to variety. *Harvest*—About the usual time—beginning of August. *Hay*—34 cwt., or 6 cwt. more than last year; quality good both as regards ryegrass and clover; secured in good order; more permanent grass seed being sown in the rotation mixtures and less ryegrass. *Meadow-hay*—Little grown; crop good, and secured in good order. *Potatoes*—About 2½ tons, or 3½ tons less than last year; no appreciable disease—simply a failure in development; tubers generally of good size, not large, and few to each stem. *Turnips*—About 12 tons per acre, or 6 tons less than last year. Turnips small; quality good; braird spoiled by frosts and cold winds, entailing much resowing. *Insects*—Generally not much damage; turnip-fly rather active in the earlier-sown turnips *Weeds*—Damage more than usual, the shortage of labour in the previous year now telling; couch-grass prevalent; spurrey or yarr bad amongst the barley. *Pastures*—Fully equal to last year's good growth. *Live Stock*—Well all the season. Cattle and sheep free from disease. *Clip of wool*—Fully over average both as to quantity and quality.

NAIRNSHIRE. *Wheat*—None grown. *Barley*—2 to 3 quarters; light weight; colour fair; small bulk of straw; about 4 bushels sown. *Oats* a light crop; 4 to 5 quarters, and small bulk of straw; not much above half a crop; 6 bushels sown. *Harvest* a week to ten days later than usual. *Hay*—A poor crop; much about the same as last year. *Meadow-hay*—None cut. *Potatoes* were most disappointing; promised well at first, but when they came to be lifted they were barely half a crop, or about 3 tons to the acre. *Turnips*—It is difficult to give figures with regard to this crop, which was very indifferent, and not equal to half an average. *Insects*—Damage not to an unusual extent. *Weeds* not more than usual. *Pastures*—The weather, particularly in the early part of the season, was very cold, and the pastures were slow in growth, and did not at any time come up to the average. *Live Stock* throve fairly well. Cattle and sheep free from disease. *Clip of wool* — Good quality; probably under an average as to weight.

INVERNESS-SHIRE (Inverness District). *Wheat*—Slight increase in acreage; return about 36 bushels per acre; weight per bushel, 59 lb.; straw, 36 to 38 cwt. per acre. *Barley*—Return below average; disap-

pointing crop; yield only about 23 bushels, and weight per bushel, 50 to 51 lb.; straw from 30 to 32 cwt. per acre. *Oats*—35 to 45 bushels per acre, and weight per bushel about 42 lb.; straw, weight per acre, 30 to 35 cwt. *Harvest* began second week of September. *Hay*—Average about 35 cwt. per acre. *Meadow-hay*—Little grown. *Potatoes*—Lightest crop on record; return barely 35 cwt. per acre, and quality under average. *Turnips*—Under average; return not over 12 tons per acre, and not healthy. Many cases of finger-and-toe. *Weeds*—Not as clean as might be; labour very short. *Pastures* above average. *Live Stock* above average. Cattle and sheep free from disease. *Clip of wool* slightly under average.

Inverness-shire (Skye). *Wheat*—None grown. *Barley*—None grown. *Oats*—A medium crop on deep, damp land, and owing to the wet summer not so good on this class of land as last season. Oats on dry land much heavier than last year; 5 to 6 bushels per acre sown. *Harvest* about a week later than last year. *Hay*—Clover and ryegrass hay was much better than last year. *Meadow-hay* was more than double the average crop. *Potatoes*—Potato crop of this season was the smallest on record, and would only amount to about the third of the crop of last year; no disease. "Arran Chief" gave double the return that the old varieties like the "Champion" and "Up-to-Date" gave. *Turnips*—A fair crop, and quality better than last year; they brairded well, and there was no second sowing. No injury by insects or weeds. *Pastures* were better than they have been for years, and our hills had double the grass on them coming to the winter than they had last year. *Live Stock* throve well. Cattle and sheep free from disease. *Clip of wool*—An average clip.

Inverness-shire (Lochaber). *Wheat*—None grown. *Barley*—None grown. *Oats*—Quantity more than last year; quality better; 5 bushels per acre more than last year; 6 bushels sown per acre. *Harvest* 14 days later than last year. *Hay*—10 cwt. per acre more than last year; quality good. *Meadow-hay* crop was less than last year. *Potatoes*—2 tons per acre less than last year; about half the crop was affected by disease, which first showed itself in July; no new varieties planted. *Turnips*—1 ton per acre less than last year. The crop brairded well, and there was no resowing. No injury by insects or weeds. *Pastures* were an average growth and quality with last year. *Live Stock* throve well. Cattle and sheep free from disease. *Clip of wool* under an average.

Ross-shire (Dingwall and Munlochy). *Wheat*—A few more acres sown than last season; quality only fair; season rather late; seed, about 4 bushels per acre. *Barley*—The usual average sown; quality of grain and straw barely average; many acres were not well harvested; quantity barely average; seed sown, about 4 bushels.. *Oats*—Quantity grown fully average, and quality of grain and straw full average on earlier fields; many later fields were gathered in bad order owing to wet weather; average, 50 bushels; seed sown, 3 to 6 bushels per acre. *Harvest*—About the usual time, but was prolonged—in many cases seriously—owing to bad harvesting weather and unequal ripening. *Hay* was a good crop; quality good, but cutting and securing was very prolonged; weight, fully 2 tons. *Meadow-hay*—None grown. *Potatoes* was very disappointing; quality not average; quantity very variable—say 2 to 6 tons per acre; disease more or less on many fields. *Turnips*—The crop was much short of average; broken weather in sowing, and cold; no second sowing, but growth very slow. *Insects*—No injury from insects. *Weeds*—Not

more than usual. *Pastures*—An average growth and quality. *Live Stock* throve very well. Cattle and sheep free from disease. *Clip of wool*—Barely average.

Ross-shire (Tain, Cromarty, and Invergordon District). *Wheat*—A poor crop, the season being far too wet and cold for this crop; quantity per acre, about 28 bushels on the average. Straw was plentiful; quality of grain bad, and natural weight very light; seed sown, 4 bushels per acre. *Barley*—A poor crop, the season being far too wet and cold for this crop; quantity per acre about 28 bushels; straw plentiful; quality of grain very poor, and natural weight very light; seed sown, about 3½ bushels per acre. *Oats*—The best of the cereal crops, not having suffered so much from the adverse weather conditions; average yield, about 50 bushels per acre; quality good where secured before weather broke; straw plentiful, but quality on the average not good. *Harvest* began about the usual time—about end of August—but owing to wet weather was long protracted. *Hay*—The heaviest crop for a number of years; average about 1 ton 15 cwt. per acre; would be 10 cwt. per acre over the previous year; quality fairly good. *Meadow-hay*—None grown. *Potatoes*—A poor crop, the wet and cold spring and summer being disastrous for this crop. The average was about 3 tons 15 cwt. per acre, being about half that of the previous year. "Arran Chief," "Summits," and "Great Scots" did best. Not much disease. *Turnips*—Average about 13 tons of swedes and 11 tons of yellows per acre. On good dry bank land they were a fair crop, but on heavy wet land a very poor crop. Not much finger-and-toe. They brairded well, and there was no second sowing. *Insects*—No damage by insects. *Weeds*—Not worse than usual. *Pastures*—There was abundance of pasture, but the quality was not good owing to the wet cold summer. *Live Stock* throve fairly well, but did not put on so much condition as usual. Cattle and sheep free from disease. *Clip of wool*—Under the average.

Sutherlandshire. *Wheat*—None grown in this (Lairg) district. *Barley*—An average crop; returns about 33 bushels per acre. *Oats*—A fair crop; return from 36 to 56 bushels per acre; about 5 bushels of seed per acre. *Harvest*—Ten days later than usual. *Hay*—Quality of hay very good; quantity from 1 to 2 tons per acre. *Meadow-hay*—About an average. *Potatoes*—A poor crop; quantity from 3 to 4 tons per acre. *Turnips*—Turnip crop very irregular; in general light—more sowings than one were frequently required; owing to cold weather braird did not come well. *Insects*—Turnips suffered damage by fly in many cases. *Pastures*—Average. *Live Stock* throve well. Cattle and sheep free from disease. *Clip of Wool*—Considerably under an average.

Caithness-shire. *Wheat*—Caithness does not grow wheat. It has been tried, but oats are preferred. *Barley*—The area under barley continues to decrease. This is mainly due to the straw of barley or bere not being so good for fodder as oat straw; about 4 quarters would be reaped; seed, from 3½ bushels per acre. *Oats*—The earliest sown oats did best this year, as the season kept very wet; fields sown about second week of April, with 5 to 6 bushels of seed, were cut about the last week of September in very good condition, and threshed out 3 to 5 quarters per acre, having been secured in very good condition. On 12th October violent winds, with heavy hail, shook off the grain and twisted the straw of all uncut oats; grain equal to between one and two seedings could be seen on the ground. *Harvest*—What was sown late was slow in ripening, and harvesting was very much delayed. The weather broke, and the stooks

were frequently thrown down by the wind, and got fairly soaked through; this made the harvest later by six or seven weeks in some instances. *Hay*—There was a very good crop of hay; there would be over 2 tons per acre of ryegrass and clover, mixed in good proportions for fodder. There was also fairly good aftermath. *Meadow-hay* came on well, but was late in being "cured" *Potatoes* were planted in sodden ground, after waiting some weeks for more favourable conditions; thus they were late at the start, and never made this up; the flowers or apples were few, and at lifting time the crop was found to be very deficient; 4 tons or so per acre was rare. The quality was good, but tubers were small.* *Turnips*—Swedish turnips this year ran to seed; yellows that followed early came on well, and good-sized healthy bulbs, of say 20 tons per acre, were grown; then a spell of wet weather continued into July, and the ground got into bad trim for sowing. The yield of bulbs and shaws together might be only 4 or 5 tons per acre. *Insects*—There was no cause to complain of the ravages of grub or turnip-fly this year. *Weeds*—Spurrey and skellock made the singling of turnips difficult; coltsfoot and sow-thistle are spreading; sourocks and dockans abound, and the winged seeds of thistles go far and near. *Pastures* kept growing very well, with the average growth and quality. *Live Stock* came on well, and got all attention for keeping up the meat supply and securing the high prices of war times. Sheep-scab and anthrax are getting rarer, thanks to the energetic efforts of the Local Authority. *Clip of wool*—Quality of the wool was good.

ORKNEY. *Wheat*—None grown. *Bere* better than last year, and better than the oats of this year, as it was cut before the gales which shook the oats; yield, about 32 bushels per acre, weighing about 48 lb. per bushel; seed, 3½ to 4½ bushels. *Oats* were sown on the last week of April and the first half of May. The weather was cold and wet all season, with little sunshine, and the oats were long in ripening. A severe storm with spindrift on the 10th and 12th October, just after harvest began, shook badly the ripe oats; but the bulk of the crop was green and heavy, and did not shake so much as one would have expected. The weather in harvest was wet, but a dry week in November enabled the farmers to secure nearly all the crops in good order. There was a big crop of straw, but the average yield of oats is only about 24 bushels per acre, weighing about 36 to 37 lb. per bushel; seed, 4 to 6 bushels. *Harvest* became general in the second week of October, being about three weeks later than usual. *Hay* was a heavy crop—nearly double the weight of last year, and was secured in good order; weight, about 32 cwt. per acre. *Potatoes* were planted late, and, owing to this and the cold wet season and to some disease, they have turned out a small crop, the yield being much less than last year; weight, about 3 tons per acre. *Turnips*—Owing to the wet weather in June some of the turnips were only sown in the first week of July; they are, however, a fair crop, but lighter than last year; weight, about 10 tons per acre. There was little injury done to the crops by either insects or weeds. *Pastures*—There was an abundance of grass all season, and stock throve fairly well considering the cold wet season, and were free from disease. *Clip of wool* was about an average.

SHETLAND. *Wheat*—None sown. *Barley*—Grain equal to last year; a fair crop. *Oats*—There was a good bulk of straw, but owing to the cold wet summer and harvest grain was a poor crop, being both small in bulk and light in weight; seed sown, from 4½ to 6 bushels. *Harvest*—Three weeks later and very wet. *Hay*—A very good crop and secured in good

condition. *Meadow-hay*—A very good crop—about double the quantity of last year. *Potatoes*—A very poor crop—about half of last year; very few new varieties are planted in this district; "Champions" are still the most profitable kind. *Turnips*—A light crop owing to the late sowing. *Insects*—No damage done. *Weeds*—Very troublesome owing to the wet season. *Pastures* during the season were of full average growth. *Live Stock* did well, especially sheep. Cattle and sheep free from disease. *Clip of wool*—An average clip.

THE WEATHER OF SCOTLAND IN 1916.

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THIS report consists of (1) a general description of the weather over the Scottish area from month to month; (2) a selection of rainfall returns, in which each county in Scotland is represented by one or more stations. It is to be noted that all the temperature readings referred to are, unless otherwise stated, from thermometers exposed in the regulation "Stevenson Screen."

JANUARY.

In all parts of our Islands the opening month of 1916 was one of remarkable mildness. In Scotland, since observations were organised sixty years ago, the only January comparable in that respect was that of 1898; and at Edinburgh, where reliable records are available from 1764 onwards, the only other January to approach those of 1916 and 1898 in mildness appears to have been that of 1796. At many places temperature never fell below the freezing-point, and almost the only interruption to a stormy south-westerly type of weather occurred towards the end of the month, with a shift of the wind to the north-west. The extreme readings were 57° at Edinburgh and St Andrews on 5th or 6th, and at Gordon Castle on 19th; and 21° at Balmoral on 28th.

An outstanding feature of the weather of 1915 had been a decided shortage of rainfall in the North-West Highlands. January 1916, on the other hand, was a month of amazing wetness in that region; rain fell on practically every day until 28th, as a rule very heavily; and at Glenquoich the aggregate of 29·27 inches was considerably above that of any January for at least forty years, and as much as 7 inches more than

was registered in the previous wettest January,—that of 1890. At Kinlochquoich there were 13 days with 1 inch or more, with falls of 2 inches or more on 3rd, 5th, 6th, 14th, and 24th—as much as 3·90 inches on 14th and 4·85 inches on 24th—and an aggregate for the three days 23rd-25th of fully 8 inches; and at Achnacarry a fall of 4·17 inches on 24th was followed by one of 2·99 inches on 25th. In some northern districts also the month was abnormally wet,—at Ardross Castle in East Ross-shire it was the wettest January for at least fifty years. At the other extreme, at points in the south-east and and south-west, the month's rainfall was slightly below the normal, and along the north-east coast there was a slight to decided deficiency. Outside the abnormally wet areas the heaviest general falls occurred during the first few days of the month, from 19th to 23rd, on 26th, and on 28th and 29th, though towards the north-east there was but little rain after 23rd. From 6th to 18th but little rain fell in eastern districts.

A great deal of stormy weather was experienced, especially during the first few days, from 10th to 15th, and from 19th to 25th. There were floods in Perthshire on 1st, and the heavy rains in the West Highlands from 23rd to 25th caused a serious landslide on the Invergarry railway. Practically no snow occurred except round 20th.

Thunderstorms occurred here and there on 4th; in west on 19th or 20th; and here and there on 22nd.

There were many gloomy days during the month, and sunshine was mostly below the normal. At Aberdeen, however, the month was the sunniest January since 1881. During the third week the north-east coast experienced exceptionally bright weather, and was the sunniest district in our Islands.

February.

The mild south-westerly type of weather which had prevailed throughout January continued during the early days of February; but on 7th or 8th a prolonged wintry spell set in, with wind from the west and north-west until about 20th, when an easterly to north-easterly type of conditions became established, persisting with only trifling interruptions until almost the end of March. The days were at times extremely cold, and around 20th very low night readings occurred,—as low as 2° at Braemar and 7° at Balmoral. The highest reading for the month was 53° at Gordon Castle on 1st.

On several days from 1st to 18th heavy falls were more or less general over a great part of the country,—rain until 6th, and mostly snow, sleet, and hail thereafter, and during that

period precipitation was of daily occurrence towards the north-west, though in the east there were various days with only trifling amounts. After 18th generally fine weather occurred in the west, with mostly unsettled conditions in east and north. On 3rd a rainstorm of considerable intensity was widely experienced, though not along the east coast,—fully 3 inches at Kinlochquoich, and more than 2 inches over considerable areas. At various places rain, or the "rainfall equivalents" of melted snow, gave amounts of 1 inch or more on every day from 5th to 8th, and on 12th, 15th, and 18th, the most persistent wet spell occurring from 12th to 18th. On 29th rather heavy falls occurred towards the south-east. In the extreme north, at Aberdeen, at Glencarron, and at points in the extreme south-west and south, the month's aggregates were slightly below, or in close agreement with, the normal. In general, however, there was an excess,—very considerable towards the south-east, and within the area bounded by the Cairngorms, the Moray Firth, and Loch Ness. At Nairn, Grantown, Braemar, Edinburgh, and Kelso, amounts were fully twice the normal.

A great deal of stormy weather occurred, and on 7th and 8th a severe snowstorm was widely experienced. There were thereafter numerous heavy snowfalls, the most notable being around 15th, and, in east and north, towards the end of the month. In hilly districts snow lay to a considerable depth continuously from 6th onwards.

Thunderstorms occurred in Edinburgh shortly after midday on 6th, early on 7th, and on the evening of 14th,—an unusual frequency for the east of Scotland in a winter month; at points in west and south on these dates; and here and there on one or two other days. Hail was frequent.

Sunshine amounts were mostly above the normal in north and west, but deficient towards the south-east.

Fog occurred in the Firth of Forth at times, but little elsewhere.

March.

For the most part there was an almost unbroken continuation of the wintry conditions which had prevailed since early in February, and the only interruptions to a persistent easterly to north-easterly type of weather occurred on 17th and 18th and at the very end of the month. Judged by its mean temperature, a colder March has occurred in Scotland during the last sixty years only in 1883 and in 1888. Day readings were conspicuously low,—on 12th in many districts the thermometer rose only a degree or two above the freezing-point,—but with very cloudy skies and consequent restriction of terrestrial radiation

the lowest night temperatures were relatively high for so wintry a month. The extreme readings were 57°,—at Colmonell on 18th and 31st, and at Crathes on 31st,—and 11° at Eskdalemuir on 24th.

As regards precipitation, the persistent easterly type of weather caused an extremely sharp contrast between eastern districts and the west and south of the country. Thus in west and south there were many rainless days; wide areas had less than half the normal; some places less than one-third; and a few less than 1 inch for the whole month. Towards the north-west there was, except on the hills, no precipitation of importance until 24th, though there were heavy falls over a limited area during the last two or three days of the month. On the other hand, in eastern districts rain, snow, or hail fell on 1st, and on almost every day from 6th to 16th and from 18th to 26th, with heaviest falls on 16th, whilst fine weather prevailed from 27th onwards. Falls on 15th, 25th, and 26th were more or less general over a great part of the country. Aggregates were hardly equal to the normal towards the north-east, but much above it in east and south-east. At Edinburgh the month was the wettest March since 1909, whilst in the West Highlands it was the driest March since that year.

Conditions were throughout disturbed, and on 25th and 26th a gale was experienced on several parts of our coasts. In regions unsheltered from the prevailing easterly to northerly winds there were numerous heavy falls of snow, the most severe snowstorms occurring around 3rd, 6th, 11th and 12th, 22nd and 25th. In various districts very serious drifting occurred, and for a parallel to such a prolonged spell of rigorous conditions in February and March in Scotland we must possibly go back to 1883.

Thunderstorms occurred here and there on 10th, 25th, and 26th.

Except in the extreme north-west and south-west sunshine amounts were below the normal,—decidedly deficient in eastern districts.

April.

After two or three mild days at the beginning of the month, temperature remained for some time at a moderate to decidedly low level in most districts, and throughout the third week a wet and very cold easterly type of weather prevailed in almost all parts of our Islands, with exceptionally cold days from 18th to 20th. On 26th there was a change to a southerly type of conditions, and the last few days of the month were decidedly mild. The extremes reported were 70° on 26th

at Fort William, Kilmarnock, and Ruthwell, and 21° at Eskdalemuir on 2nd.

The first eight days or so were dry nearly everywhere, and in some eastern districts the first half of the month was all but rainless. In west and south there were moderate to heavy falls from 10th to 13th. From 16th to 25th conditions were very unsettled, with persistent rain in the east from 16th to 20th. In Mid-Lothian on 18th and 19th, and at one or two points in central and in hilly southern districts on 23rd and 24th, the falls were very heavy. The last few days of the month were practically everywhere rainless. Aggregates were in general appreciably above the normal, though below it at Perth and parts of Forfarshire.

Thunderstorms occurred at one or two points on 12th, 14th, or 21st; and hail or slight snow somewhat widely around 14th.

The third week was extremely gloomy, but during the first half of the month and the last few days considerable amounts of sunshine were experienced in most districts, and the second week was exceptionally sunny except towards the north-west. Aggregates were below the normal in most northern districts, slightly above it elsewhere.

MAY.

During the first half of the month temperature did not rise above a moderate level, and at times the days were very cold. From 18th to 20th, on the other hand, the days were extremely warm, and in most districts temperature was on the whole fairly high until the end of the month. The lowest reading reported was 28° (at Gatehouse on 10th, at Braemar on 11th, and at Balmoral on 14th), and there have been only two or three occasions during the last sixty years on which temperature has not fallen to some lower level in the month of May. The highest reading was 77° at Gordon Castle, Dumfries, and elsewhere on 19th or 20th.

Heavy rains were more or less general from 5th to 7th, and unsettled weather from 11th to 17th was followed by three rainless days. On 31st a ten days' spell of wet weather set in and heavy rains from south-west were general,—at Greenock as much as 1·80 inch, or one-third of the month's total. In all districts aggregates were at least equal to the normal, and very generally there was a considerable excess. In the Moray Firth area, at Poltalloch, and in parts of Fife and East Lothian, amounts were fully twice the normal. At Glasgow the month was the wettest May for at least fifty years, but, as a rule, in west and south it was less wet than May 1913.

There was a severe thunderstorm towards the north-east on morning of 6th, with heavy falls of snow, sleet, and hail. From 27th to 29th thunderstorms of more moderate intensity occurred in many districts on one or two days.

A few very sunny days did not compensate for much cloudy weather, and sunshine aggregates were below the normal.

June.

With winds largely from north and north-east the month was an extremely cold one, and, speaking generally, a colder June has occurred in Scotland during the last sixty years only in 1907 and 1888. The nights were not as a rule conspicuously cold, but even at Glasgow ground frost occurred on one or two occasions. On the other hand, practically the only interruption to persistently cold days occurred about 14th, 17th, and 23rd, when fairly high temperatures were reached. The extreme readings reported were 81° at Buchlyvie on 17th, and 30° at West Linton and elsewhere on 14th, and at Braemar on 16th.

Unsettled conditions prevailed in most districts during the first ten days of the month, with some heavy falls towards the north on 5th and 6th; whilst from 11th to 20th there was a practically rainless spell throughout Scotland. On 22nd unsettled conditions again set in, with widespread heavy falls in east and north on 24th. The last two or three days were dry in most districts, but wet towards the north and north-east. Aggregates were above the normal in eastern districts; greatly in excess in Aberdeenshire and around the Moray Firth; and more that thrice the normal at Nairn. At Aberdeen the month was much the wettest June for at least fifty years. The area of excess, however, did not extend far inland, and in west and south there was a well-marked shortage.

Early in the month and around 12th and 13th stormy weather prevailed.

Thunderstorms occurred somewhat widely on 1st and 2nd, and here and there on 8th and 24th. On 6th freshly fallen snow covered Ben Nevis down to nearly 2000 feet.

A fair amount of sunshine was experienced in west and south. In east and north, however, in spite of a few sunny days during the third week, aggregates were much below the normal; during the last thirty-five years a cloudier June has been experienced only in 1912; and the last week of the month was exceptionally gloomy, with much fog around our northern coasts.

July.

The cold weather for which June had been notable persisted almost continuously until near the end of the third week of July, with frequent winds from east and north, cloudy skies, and some extremely cold days. During the last ten days of the month, on the other hand, some very warm and sunny weather was experienced, and between 23rd and 27th various readings of 80° or over were reported. The extremes were 84° at Buchlyvie and Paisley on 23rd, and 32° at Glen, near Innerleithen, on 6th.

There were moderate to heavy falls in many districts during the first few days, and the month was notable for rains of abnormal intensity which visited a large part of the country on 7th and 8th, during the passage of a shallow depression which crossed our Islands in an east-south-easterly direction from off the south of Ireland to the North Sea. These rains fell through a light east wind. Within twenty-four hours nearly all central and eastern districts received at least 1 inch; wide areas more than 2 inches; and parts of Forfar, Perth, Fife, and Mid-Lothian fully 3 inches. The rainfall at Leith on 7th was 3·32 inches, and at Edinburgh (University) 3·08 inches, and during the last hundred years in the Edinburgh area the only rainstorm comparable in intensity has been that of 15th October 1907. In west, south, and on the fringe of the north-eastern counties, amounts were more moderate, and in the extreme north little or no rain fell. Amounts on 8th were heavy only in parts of Forfarshire and Perthshire,—as much as 1·90 inches at Perth. After these heavy rains conditions remained somewhat unsettled for a few days, but in some districts there were no falls of importance after 11th; in many practically no rain after 16th; and in general fine weather during the last two weeks was interrupted only by very local thunderstorms. On 22nd Ballintuim, near Blairgowrie, had as much as 2 inches, and on the 24th Fortrose 1·34 inch. Aggregates were below the normal in some western districts, and in the extreme north and north-west, but in general there was an excess, and Dundee and Leith had fully twice, and Perth thrice the normal. On 7th the wettest areas had more rain than fell in the driest areas during the whole month. Of the month's total of 9·44 inches at Perth, fully 8½ inches was accounted for on six days, and during the last fifty years the only month at that place with a larger aggregate has been December 1876 (10·94 inches).

Serious flooding occurred in many districts on 7th and 8th.

Thunderstorms of considerable intensity, but somewhat local

in character, occurred in various districts, but chiefly in west and north between 21st and 27th.

The first three weeks of the month were for the most part very cloudy, and in spite of bright weather during the last ten days sunshine aggregates were much below the normal.

August.

The fine dry and warm type of weather which had prevailed during the last ten days or so of July continued practically unbroken until 12th or 13th August, when easterly winds again set in, with temperature as a rule below the normal in north and east, but above it in west and south. On 29th ground frost occurred in many districts. The extremes reported were 84° at Kelso (Broomlands) on 5th, and 33° at Perth and West Linton on 29th.

Except for unimportant amounts on 1st, little or no rain fell until 11th or 12th, when a three weeks' spell of very fine weather, during which rain of importance had occurred only very locally in thunderstorms, gave place to unsettled conditions. There were some rather heavy falls on 14th and 15th, and fine weather from 21st to 23rd was again followed, except in the extreme north, by a very disturbed type of conditions, with falls exceeding 1 inch over wide areas on 25th,—as much as 2·50 inches at Lednathie, and 2·14 inches at Dundee,—and some rather heavy falls on both 24th and 26th; at Aberdeen rain was practically continuous for forty-eight hours, with a total fall of about 2¾ inches. The last four days of the month were practically rainless in many districts, but moderate falls occurred at places on 29th and towards north-west on 31st. Very generally in north, west, and south the month's aggregates were well below the normal; but in eastern districts the heavy falls of 14th and 15th, and from 24th to 26th, brought about a moderate excess.

Thunderstorms occurred here and there around 10th; and in various districts, but more especially in the west, on one or more days between 15th and 18th.

Sunshine was abundant between 4th and 10th, whilst the period from 24th to 27th was exceptionally gloomy in the east. Aggregates were above the normal in the west, but decidedly below or hardly equal to it in the east. Much coast fog or mist occurred.

September.

Fairly warm weather was experienced during the first twelve days or so of the month, with very mild nights from 6th to

8th; but thereafter, with winds at times from an easterly or northerly quarter, there was some sharp touches of cold, especially around 21st. The extremes reported were 75° at Crathes on 6th, and at Edinburgh on 8th, and 28° at West Linton on 21st.

The month was much the driest of the year in practically all districts, and a great deal of rainless weather was experienced. Aggregates were largely accounted for on two or three days; and a great part of the country had less than one-half the normal, and some places less than 1 inch for the whole month. There were, however, rather heavy falls in east and south on 3rd—when Edinburgh had for the fourth time during the year more than 1 inch in twenty-four hours—and from 11th to 18th conditions were rather unsettled, with some heavy falls in western and inland districts on 17th and 18th. Thereafter hardly any rain of importance fell except in some eastern and central districts on 27th. At Edinburgh two-thirds of the month's total was accounted for on 3rd. In the extreme south-east aggregates were equal to or slightly above the normal; but in nearly all districts the month's rainfall was very deficient.

Strong and very squally winds were experienced on 17th and 18th.

A thunderstorm occurred at Edinburgh on afternoon of 4th.

Sunshine aggregates were below the normal in the north, but fully equal to it in the south. Much coast fog or mist occurred.

October.

The mean level of the barometer for the month was abnormally low, and there was some considerable fluctuations of pressure. On 14th, when a very deep depression moved on a north-westerly track off the north of Scotland, there was in northern districts a fall of fully 1 inch, followed by an equally rapid recovery. Exceptionally wet and stormy weather was associated with the approach and passage of this depression.

The nights of 2nd and 3rd were cold, but the first two weeks were in general mild, and during the second week the nights were especially mild. On 15th colder conditions set in, and the mean temperature of the second half of the month was much below that of the first half. The extreme readings were 70° at Gordon Castle on 4th, and 17° at Braemar on 17th.

The period from 3rd or 4th to 14th was very wet in all districts, with some abnormally heavy falls towards the north-west. Fort William had as much as 4½ inches on 11th, nearly 3½ inches on 14th, and a total for the week ending 14th of

nearly 12 inches; Glenquoich had as much as 5·82 inches on 11th, 3·42 inches on 14th, and a total for the week of fully 16 inches; whilst a fall of 8·20 inches at Kinlochquoich on 11th appears to be the heaviest rainfall ever registered within twenty-four hours in our Islands, and the total at that place for the week was fully 18½ inches. Between 16th and 26th conditions were less unsettled, with a few fine days, but from 27th onwards the weather was again of a very disturbed type. In all districts the month's aggregates were above the normal; in most the excess was large; and in not a few amounts were considerably more than twice the average. At Fort William the month was decidedly the wettest October on record; but at Glenquoich October 1890 was slightly wetter. The month was a very wet one in all parts of our Islands, and relatively to the normal the excess was even greater in Ireland than in Scotland.

A great deal of squally and stormy weather occurred, especially from 10th to 15th and from 25th onwards. Between 12th and 14th there was extensive flooding in various districts, with interruptions to traffic on the West Highland Railway owing to "wash-outs."

A thunderstorm occurred at points in western and southern districts on 7th or 10th.

Sunshine aggregates were below the normal, and much fog or mist occurred.

November.

There were again rapid fluctuations of atmospheric pressure, and the mean height of the barometer for the month was lower than in any November since 1882.

Winds from south and south-west were of unusual frequency, and the month was in general an unusually mild one, especially as regards the nights. There were, however, brief incursions of cold around 18th, with easterly winds, and again on 27th and 28th, with winds from north-west. The extremes reported were 62° at Gordon Castle and Banff on 11th, and at Arbroath and Lednathie on 13th, and 20° at Leadhills on 18th.

During the first week there were some considerable rainfalls in nearly all districts, and in west and north-west unsettled conditions continued until 11th; on 18th and 19th some heavy falls occurred in eastern and inland districts; whilst on 23rd and 24th and around 28th moderate to heavy falls were more or less general. Amounts of 2 inches or more occurred in Central Perthshire on 3rd; at Glenquoich on 10th and 23rd; and at Lednathie in Forfarshire on 19th. The period from 10th or 11th to 17th was in general dry. In the north, at

Glasgow, and towards the extreme south-west, the month's aggregates were below the normal; but in general there was a well-defined excess,—fully 50 per cent at Fort William, Dundee, and Perth, and as much as 70 per cent in parts of Berwickshire.

From about 3rd to 6th, and again from about 17th to 20th, the weather was of a very stormy and unsettled type, with winds from east or south-east: some damage to shipping and loss of life occurred. Showers of snow, sleet, and hail were experienced in many districts on 18th, and in some about 26th.

A thunderstorm occurred in some western districts on 1st.

Sunshine aggregates were in general below the normal.

December.

The month was the third in succession with an abnormally low pressure, and the mean for the October-December period was lower than in any year since 1872.

Mild conditions during the first day or two were followed by a sharp fall of temperature on 5th, and thereafter cold to rather cold weather prevailed until nearly the end of the month, though the cold was less severe than that experieneed in England at the same time. From about 15th to 20th the weather was of a definitely wintry type. Very mild conditions prevailed during the last three or four days of the month. The extremes were 54° at Comlongon Castle (Ruthwell) on 29th, and 11° at Carrbridge and West Linton on 20th.

On 2nd and on 6th or 7th there were some moderate rainfalls in various districts; on 9th some heavy falls in eastern and central districts,—more than 1½ inches at Perth and Kenmore,—with unsettled conditions during the next two or three days; and from 15th to 25th various days in all except northern districts, on which there was considerable precipitation, much of it consisting of snow. Various heavy falls occurred during the last three or four days of the month. Towards the north-west the month's aggregates were below the normal; in south and at points in the west in close agreement with it; and in eastern districts somewhat in excess.

Snow and hail occurred in some districts around 5th and 6th, and after moderate falls on 17th and 18th a snowstorm of considerable intensity was rather widely experienced on 19th and 20th. At Glasgow on 19th snow lay to a depth of from 6 to 9 inches. Around 24th there were some further falls of snow. Wind force was high around 21st and at the close of the month.

Sunshine aggregates were in general decidedly deficient. A good deal of coast mist and some fog occurred.

General Note.

Outstanding features of the weather of 1916 were the prolonged spell of wintry weather in February and March which put a stop to agricultural operations; the cold spell in June; and a general deficiency of sunshine. The instrumental registration of sunshine (by the Campbell-Stokes recorder) goes back to 1881, and in the Orkneys and at Stornoway the year was the cloudiest on record; very generally, however, 1912 was a cloudier year, and here and there 1913 was also cloudier.

Relatively to the average, rainfall aggregates showed a very irregular distribution. Thus in the extreme south-west there was at some points a shortage over the year as a whole, and nowhere in west and south was there a large excess. In eastern districts, on the other hand, amounts were much above the average, and the relatively greatest excess, amounting to about 50 per cent, occurred at Edinburgh, Perth, and Nairn. At Edinburgh the year has been approached in wetness only by 1872; but at Perth, and even more so at Nairn, the year was the wettest on record. Elsewhere within the wet areas amounts were at many places less than in 1872, 1877, or 1903, and the general rainfall of Scotland was certainly greater in each of these years than in 1916. It further calls for remark that the number of "rain days" was in general less in 1916 than in the wet year of 1903. This was so even at Perth, where the total for 1916 exceeded that of 1903 by several inches. Attention has been drawn to various very heavy rainstorms during which more than one "record" was established, and probably an unusually large proportion of the year's rainfall was accounted for on a few very wet days.

Rainfall Records for 1916 in Inches.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Shetland—Lerwick .	10·79	3·94	4·53	2·99	5·43	2·68	2·74	·91	2·24	8·39	6·81	5·94	57·39
Orkney—Deerness .	5·96	2·89	3·07	2·08	2·33	3·22	1·77	1·01	1·72	6·19	4·08	4·15	38·47
Caithness—Wick . .	2·99	1·34	2·09	1·69	3·05	3·39	1·30	1·22	1·26	3·70	2·60	3·35	27·98
Sutherland—Tongue .	5·25	3·20	2·56	2·70	3·86	4·80	2·21	·99	2·01	4·20	4·90	3·94	40·62
Dunrobin . . .	5·04	3·14	2·53	1·95	3·57	2·99	1·94	3·03	1·51	5·07	2·37	2·77	35·91
Dornoch . . .	3·49	2·77	1·96	1·62	3·01	2·44	2·62	2·19	1·14	4·78	2·23	2·42	30·67
Ross and Cromarty—													
Fortrose . . .	3·16	3·02	1·86	1·57	3·54	4·24	4·16	2·48	·99	5·39	1·93	2·29	34·63
Ardross Castle . .	7·63	4·61	3·67	2·83	3·36	4·67	3·32	2·76	1·69	7·79	3·05	3·35	48·78
Glencarron . . .	16·30	7·11	3·90	6·13	5·51	4·78	4·08	2·87	3·04	14·67	8·77	7·85	85·41
Stornoway . . .	8·47	6·02	2·99	3·52	3·54	2·05	1·73	1·10	2·72	5·67	5·63	5·24	48·98
Inverness—Inverness .	3·69	3·78	1·55	2·06	3·78	3·87	4·01	1·80	·82	5·37	2·89	1·55	34·95
Rothiemurchus . .	4·66	6·76	2·19	3·14	3 69	4·07	3·11	3·56	1·24	6·61	4·38	2·76	46 12
Glenquoich . . .	29 27	13·05	4·71	8·09	5·94	2·67	5·83	4·39	6·41	21·69	17·80	11·35	131·23
Fort William . .	15·19	10·44	2 14	5·47	4·27	1·84	2·91	4·23	2·53	16·20	11·79	6·14	83·15
Nairn—Nairn (Delnies) .	3·35	3·58	1·69	1·77	3·78	5·98	3·94	2·13	·91	5 24	1·97	2·41	36 75
Elgin - Gordon Castle .	2·09	2·57	2·21	2·72	4·41	6·08	3·24	2·70	1·10	3·86	2·85	2 01	35·84
Grantown . . .	2·73	4·28	2·19	2·31	4·89	5·99	3·12	3·64	1·88	4·53	3·28	1·96	40·80
Banff—Banff . . .	1·31	1·57	2·24	2·52	3·39	3·96	2 11	2·66	·78	4·08	2·91	2·63	30·16
Aberdeen—Fyvie Castle	1·29	2·36	3·52	3·49	4·70	5·58	2·09	2 99	1·52	6 15	3·98	3·91	41·88
Peterhead . . .	1·15	1·87	2·22	2·12	3·86	4·75	1·91	2·49	1·69	4·95	2·90	5·12	35·03
Aberdeen (King's Coll.)	·95	2·13	2·25	2·64	3·34	4·65	3·23	3·43	1·69	3·66	3 27	4·38	35·62
Balmoral . . .	3·09	3·70	3·38	2·49	2·59	3·05	3·77	3·71	1·57	6·13	5·01	3·76	42·25
Kincardine—The Burn .	2·29	3·00	3·37	2·19	3·12	2·88	7·17	3·28	1·30	5·95	5·56	5·41	45·52
Forfar—Montrose . .	·92	2 21	2·52	1·67	2·83	3·66	6·73	3·55	1·08	4·08	3·39	3·27	36·31
Dundee	1·84	2·26	3 22	1·42	3·73	2·89	7·52	3·94	1·70	4·53	3·86	3·81	40·72
Forfar	1·98	2·86	3·70	1·90	3·19	2·63	6·30	4·28	1·13	4·49	5·34	4·93	42·73
Lednathie . . .	3·40	3 76	2·81	2·23	3·69	3·06	6·71	4·8.	1 41	6·94	7·34	5·65	51·82
Perth—Perth . . .	3·65	4·25	3 12	1·65	3·93	2·11	9·44	2 99	1·40	6 81	4·51	3·70	47·56
Crieff	6·29	5·02	2·36	2·91	3·31	2·47	4·75	2·95	1·29	6·68	5·37	4·95	48·85
Killin	13·57	9·67	2·39	4·24	4·11	1·62	5·01	2·90	1·51	11·45	9·72	6·20	72·39
Stronvar . . .	14·79	9·77	2·25	6·32	5·36	2·45	4·47	2·99	1·31	12 46	10·79	8·08	81·04
Aberfoyle . . .	10·30	6·60	2·10	3·65	5·60	2·55	3·55	4·00	1·15	10·10	7·50	5·60	62·60
Fife—St Andrews . .	1 87	2·65	2·77	2·02	2·90	3 41	5·96	3 43	1·55	3·78	4·05	3·40	37·79
Kinross—Loch Leven .	5 31	3·59	3·83	2·49	3·03	3 55	5·87	3·03	1·36	5 98	6·30	4·30	48·84
Clackmannan—													
Alloa (Waterworks) .	4·33	3·85	2·86	1·92	4·23	3·15	4·60	2·73	1·02	5·85	4·55	3·55	42·64
Argyll—													
Lochbuie (Mull) . .	11·33	8·67	2·01	8·51	9·68	2·62	3·22	5·05	5·28	13·90	11·49	8·77	90·53
Oban	6·86	6·04	·74	4·20	4·60	2·25	2 56	4·38	2·20	8 98	7·03	5·38	55·22
Taynuilt . . .	12·92	9·46	2·40	4·48	4·60	2·14	3·16	3·75	2·28	11·36	9·79	6 71	73·05
Ardrishaig . . .	9·20	9 17	2·95	7·29	5·53	2·44	2·66	4·00	3 26	10·58	8·24	6·38	70·70
Campbeltown . .	4·95	5·05	1·99	3·41	4 8	1·41	2·43	3·25	2·25	6·59	5·14	6·00	47·29
Bute—Rothesay . .	6·59	5·74	1·35	1·40	4·32	1 79	2·27	5 52	2·05	7·41	5·41	5 48	52·33
Stirling—Kilsyth . .	7·26	5·16	2·64	4·42	5 71	2·74	3·98	4 31	1·25	8 28	4·23	7·85	57·83
Falkirk (Laurieston) .	5·18	4·60	2·75	2·17	4·76	3·33	3·69	3·24	1·09	6 52	4·11	4 04	45·48
Dumbarton—Dumbarton	6 18	5·06	1·98	3·57	3·87	2·56	2·25	3·78	·78	8·25	5·32	6·57	50·17
Renfrew - Greenock .	10·04	8·30	2·24	4·95	5·33	2·17	2 73	4·87	2·38	9·90	7·82	7·86	68·09
Paisley	6 46	5·54	1·84	3·28	4·44	1·92	2·68	3·32	98	8·19	4·40	5·30	48·35
Ayr—													
Kilmarnock (Ag. Coll.)	4·60	4·01	1·19	3·51	3·65	1·91	3·96	3·40	2·05	6·15	3·42	5·08	42·96
Knockdon . . .	4·26	3·67	1·00	3·96	3·60	1·55	3·71	3·73	1·40	5·36	4·20	5·19	41·63
Turnberry . . .	2·98	2·58	·48	2·28	2·48	1 19	2·78	3·14	·89	4·17	2·58	4·05	29 60
Barr (The Manse). .	5·58	4·72	1·15	4·69	4·57	2·16	5·23	2·24	2·12	6·92	5·10	7·12	51·60
Lanark—													
Glasgow (Observatory)	4·60	3·97	2·15	3·35	4·68	2·12	3·43	3·77	·79	7·17	3·26	4·93	44·22
Hamilton . . .	5·34	4·62	1·74	2·47	4·47	2·50	2·82	5·36	·96	5·60	3·63	3·93	43·44
Lamington . . .	4·94	4·90	2·83	2·52	4·21	2·82	5·47	3·55	2·32	4·99	3·42	2·06	44·03
Leadhills . . .	12·48	7·57	4·80	6·34	4·24	4·39	5·33	5·53	4·23	10·58	8·14	6·37	80·80
Linlithgow—													
Bathgate (Boghead) .	5·18	5·52	3·24	3·39	5·44	2·84	4·02	3·79	1·52	6·81	3·78	4·17	49·70
Mid-Lothian—													
Edinburgh (University)	2·86	3·78	3·33	2·13	3·79	2·62	5·98	4·81	1·27	4·57	3·21	2·70	41·05
Balerno (Cockburn Hill)	5·08	5·67	4·50	4·33	4·86	3 17	5·57	5·75	1·70	6·41	5·34	3·93	56·31
Haddington—													
Gullane	2·12	3·37	3·11	1·78	3·58	3·70	4·44	3·90	1·42	3·82	3·67	2·65	37·56
Donolly (Reservoir) .	2·73	3·90	5·26	2·25	5·00	4·23	3·92	4·59	3·50	4·85	5·61	3·47	49·31
Berwick—Marchmont .	2·24	4·21	4·42	2·68	3·10	2·08	5·81	4·25	2·68	4·25	5·37	3·91	45·00
Peebles—Glen . .	6·31	5·75	3·77	3·06	3·63	3·63	5·33	3·29	2·52	6·89	5·96	3·92	54·06
Selkirk — Selkirk (The Hangingshaw) . .	4·31	4·83	4·31	3·06	4·59	1·68	5·28	4·00	2·19	5·31	5·05	3·30	47·91
Roxburgh—													
St Boswells (Fens) .	2·28	3·71	3·22	1·92	3·50	1·67	3·61	4·41	1·77	3·69	3·88	2·68	36·29
Branxholme . . .	4·08	4·14	3·51	2·10	3·34	1·91	4·33	3 80	2·05	6·22	4·78	2·98	43·24
Dumfries—Dumfries .	3·71	2·60	1·26	2·02	3·35	1·56	4·01	2·99	1·70	6·49	3·58	3·99	37·46
Drumlanrig . . .	7·09	5·41	1·74	3·47	3·59	1 68	3·89	5·26	1·31	8·60	5·65	5·93	58·62
Beattock (Kinnelhead)	9·96	5·50	1·46	5·15	5·57	2·66	5·76	5·00	3·52	11·14	6·05	6·02	67·79
Langholm . . .	7·85	4·38	3·32	4·16	3·90	2·88	6 05	4·29	2·55	8·98	6·12	4·52	58·95
Kirkcudbright—Cargen	6·68	4·51	1·73	3·08	4·50	1·95	5·18	4·08	2·48	8·14	5·63	5·01	52·95
Dalbeattie (Lit. Richorn)	5·19	4·51	1·48	2·57	3·86	2·16	3·42	5·17	1·62	8·20	5·14	6·12	49·44
Carsphairn (Shiel) .	12·22	8 00	1·53	7·66	4·67	3·99	5·65	4·16	3·08	12·25	7·95	7·86	79·02
Wigtown—Galloway H'se	3·06	3·30	1·60	2·21	2·52	2·01	2·51	2·07	·99	6·58	3 28	4·22	34·85

AGRICULTURAL STATISTICS.—Returned upon 4th June 1916—(*Compiled from the Government Returns*).

Table No. 1.—Acreage under Crops and Grass in each County of Scotland.

Counties.	Total Acreage under Crops and Grass.*	Arable Land.	Permanent Grass.	Corn Crops.						Potatoes.	Turnips and Swedes.	Mangels.	Cabbage.	Rape.	Vetches or Tares (Seed).	Vetches, Tares, Beans, Mashlum, &c. (Fodder).	Small Fruit.	Rye-grasses and other Rotation Grasses and Clover.	Other crops.	Bare Fallow.
				Wheat	Barley, including Bere	Oats	Rye.	Beans.	Peas.	Total.										
	Acres.	Acres.	Acres.	Acres	Acres.	Acres.	Acres	Acres.	Acres	Acres.	Acres.	Acres	Acres	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
1. Aberdeen	627,066	591,834	35,232	26	19,080	192,440	181	13	148	211,888	6,761	82,169	..	140	34	142	2,796	291	287,188	229	251
2. Argyll	131,827	56,667	75,169	6	1,471	17,482	236	29	.	19,224	3,528	5,720	24	45	150	3	33	21	27,568	28	388
3. Ayr	316,063	141,005	175,058	1,493	514	46,160	120	812	14	49,113	8,545	7,259	518	258	373	1	984	238	73,087	168	461
4. Banff	159,214	148,782	10,432	..	6,595	49,074	45	41	29	55,784	1,769	20,230	2	8	9	98	797	15	69,872	5	198
5. Berwick	191,713	137,696	54,017	2,112	18,170	31,610	50	436	9	52,387	2,082	23,715	217	92	474	66	402	27	58,015	34	185
6. Bute	25,173	14,856	10,317	15	26	4,793	46	34	11	4,925	1,015	1,310	10	32	114	1	2	39	7,848	11	59
7. Caithness	109,747	83,019	26,728	.	957	30,757	2	.	2	31,716	1,434	12,003	..	23	..	32	270	7	37,358	5	171
8. Clackmannan	15,511	8,561	6,950	292	192	3,116	13	264	1	3,878	364	689	1	10	22	..	154	17	8,259	2	165
9. Dumbarton	47.521	24,200	23,321	750	36	7,642	.	34	2	8,464	2,329	1,315	8	108	152	2	54	56	11,642	26	42
10. Dumfries	251,394	134,563	116,831	109	400	42,296	50	24	4	42,883	3,512	15,656	326	190	732	4	47	62	70,961	46	124
11. Edinburgh	122,893	79,768	43,125	6,627	5,345	21,376	8	.	94	33,450	6,008	9,467	60	546	380	15	172	182	29,016	383	89
12. Elgin or Moray	99,035	90,518	8,517	706	8,927	25,004	420	7	17	35,090	1,719	13,878	20	8	15	37	255	15	39,296	17	168
13. Fife	246,672	171,467	75,205	12,258	16,827	43,882	596	285	22	74,170	14,453	21,345	51	172	428	42	512	237	59,302	81	674
14. Forfar	247,110	220,689	26,421	11,638	22,087	54,913	1,083	37	20	89,778	15,005	30,473	20	151	71	8	416	352	84,145	118	152
15. Haddington	111,714	89,959	21,755	6,935	14,727	17,746	1	179	113	39,691	6,790	18,322	318	451	282	14	103	296	28,201	320	171
16. Inverness	147,447	85,129	62,318	266	5,824	29,187	876		14	36,167	5,697	9,499	4	45	35	20	66	21	32,810	28	746
17. Kincardine	119.247	108,649	10,598	1,413	11,135	29,787	46	41	21	42,443	3,088	15,601	4	29	1	10	398	70	46,875	61	69
18. Kinross	33,972	20,484	13.488	154	290	6,544	74	4	1	7,067	914	2,292	2	20	84	1	32	25	10,018	4	26
19. Kirkcudbright	186,496	91,048	95,448	49	147	26,231	50	38	1	26,516	1,759	10,624	137	91	1010	4	12	17	50,891	34	158
20. Lanark	250,126	129,334	120,792	2,542	214	40,555	25	145	13	43,494	4,849	9.128	25	629	915	4	542	1,988	67,019	450	291
21. Linlithgow	57,194	33,930	23,264	2,549	2,173	11,169	4	24	6	15,925	2,183	3,130	12	71	240	7	173	44	12,014	15	116
22. Nairn	25,556	23,075	2,481	..	2,167	6,454	32	.	..	8,653	266	3,796	12	3	10	6	23	5	10,217	9	78
23. Orkney	108,357	93,093	15,264	..	3,819	33,914	14	..	4	37,751	2,711	13,974	..	25	1	11	244		38,216	1	159
24. Peebles	50,366	25,096	25,270	3	306	6,849	2	..	3	7,163	298	3,203	1	28	487	3	33	16	13,735	14	117
25. Perth	330,894	228,127	102,767	7 092	6,532	70,805	967	904	17	86,317	14,628	24,815	48	184	638	29	542	2,694	97,859	68	810
26. Renfrew	84,841	35,542	49.299	2,205	48	11,158	22	102	2	13,537	2,851	1,967	80	173	96	2	40	125	16,593	55	78
27. Ross & Cromarty	138,630	109,569	29,061	1,595	8,346	31,682	409	8	12	42,052	6,332	14,710	14	113	43	81	266	29	45,532	2	395
28. Roxburgh	178,257	111,575	66,682	503	10,115	28,479	..	111	7	39,215	1,135	19,242	96	145	473	22	191	36	50,845	55	120
29. Selkirk	28,911	16,026	12,885	..	279	4,221	..	..	2	4,502	199	2,462	..	23	82	16	37	7	8,667	5	26
30. Shetland	30,415	14,212	16,203	..	796	6,539	..	..	4	7,339	2,429	1,044	..	655	1	..	14	.	2,082	6	602
31. Stirling	114,412	55,158	59,254	1,604	1,367	19,283	11	1,775	5	24,045	3,099	3,864	18	151	346	16	690	192	21,913	78	746
32. Sutherland	31,188	22,755	8.383	1	532	7,773	28	..	2	8,276	1,304	2,774	3	7	10	5	31	3	10,231	4	107
33. Wigtown	156,594	107,355	49,239	140	295	31,730	22	93	1	32,281	1,265	13,633	366	47	154	..	164	8	59,164	84	289
Total	4,775,606	3,303,741	1,471,765	63,083	169,739	990,589	5,742	5,440	591	1,235,184	130,119	414,320	2,347	4,673	7,862	704	10,495	7,127	1,480,329	2,386	8,195

* Not including mountain and heathland.

TABLE No. 2.—TOTAL PRODUCE OF WHEAT, BARLEY, AND OATS, ACREAGE and YIELD per Acre in the Year 1915, compared with the YIELD for the Years 1914 and 1913, and the AVERAGE of the Ten Years, 1905-1914, in each COUNTY of SCOTLAND.

WHEAT.

Counties	Total Produce in 1915.	Acreage in 1915.	Yield per acre. 1915.	Yield per acre. 1914.	Yield per acre. 1913.	Average of the Ten Years, 1905-1914.
	Qrs.	Acres.	Bush.	Bush.	Bush.	Bush.
Aberdeen	234	58	32.29	30.18	..	*32.42
Argyll	..	..	..	†	16.00	‡24.33
Ayr	8,885	1,527	46.55	45.93	47.39	45 36
Banff	28	8	28.00	..	.	—
Berwick	14,621	3,162	36.99	41.82	39.44	39.22
Bute	12	2	45.50	45.00	44.67	‡44.08
Caithness	..	..	..	.	.	.
Clackmannan	3,194	559	45.71	47.74	45.92	44.33
Dumbarton	4,905	1,006	39.01	38.33	36.49	36.93
Dumfries	621	118	42.06	37.90	38.38	37.97
Edinburgh	45,617	7,892	46 24	48.40	47 44	47.20
Elgin or Moray	4,063	789	41.20	43.32	42.30	41.08
Fife	62,563	15,239	32.84	38.99	40.74	38.82
Forfar	56,492	12,530	36.07	40.17	37.68	38 36
Haddington	43,840	8,249	42.52	47.33	44.24	43 64
Inverness	1,540	312	39.48	41.57	38.45	39.82
Kincardine	1,219	226	43.17	48.72	46.38	43.21
Kinross	6,879	1,416	38 86	38.47	37 62	36.23
Kirkcudbright	331	63	42.03	40 00	36.00	36.58
Lanark	13,050	3,034	34.41	36.50	34.92	35.33
Linlithgow	17,197	3,158	43 57	47.18	45.50	44.10
Nairn	220	49	36.00	38.00	36.00	‡34.17
Orkney	..	..	..	..	..	..
Peebles	15	3	39.43	..	..	—
Perth	44,406	9,234	38.47	40 93	38.59	38.47
Renfrew	11,743	2,361	39.79	38.37	44.31	40.61
Ross and Cromarty	11,554	2,126	43.48	43.17	40.95	37.06
Roxburgh	3,371	789	34.18	40 49	38 50	36 07
Selkirk	190	43	35.40	32.00	35.00	*32.00
Shetland	..	..	.	.		
Stirling	12,007	2,486	38.64	51.91	43.38	46 51
Sutherland	..	..			..	—
Wigtown	1,122	215	41.72	43.16	39.13	36.69
Total	369,919	76,654	38.61	42.31	41.32	40.58

BARLEY, INCLUDING BERE.

Counties	Total Produce in 1915.	Acreage in 1915.	Yield per acre. 1915.	Yield per acre. 1914.	Yield per acre. 1913	Average of the Ten Years, 1905 1914.
	Qrs.	Acres.	Bush.	Bush.	Bush.	Bush.
Aberdeen	71,997	16,904	34.07	37.37	35.37	34.29
Argyll	6,585	1,299	39.33	37.34	40.74	37.94
Ayr	2,009	334	48.12	38.72	41.14	39.64
Banff	20,189	5,634	28.67	38.14	37.57	35.15
Berwick	65,976	16,320	32.31	37.35	35.71	36.08
Bute	46	9	40.89	36.67	37.85	34.78
Caithness	3,126	779	32.10	31.20	34.83	29.87
Clackmannan	461	108	34.15	34.63	35.67	35.98
Dumbarton	141	33	34.13	34.72	30.84	33.86
Dumfries	1,847	417	35.43	38.34	38.41	37.52
Edinburgh	21,111	3,831	44.08	44.41	42.26	42.95
Elgin or Moray	31.140	8,190	30.42	36.90	37.42	35.42
Fife	65.755	13,828	38.04	39.35	38.88	37.64
Forfar	83.134	20.408	32 45	37.55	36.80	37.97
Haddington	64.725	11.940	42.37	49.05	45.40	43 13
Inverness	15.618	5,505	22 33	26.72	31.47	29.30
Kincardine	40.800	10.150	32.10	36.36	35.95	32.94
Kinross	1,007	218	36.95	34.92	35.07	36.51
Kirkcudbright	615	124	39 70	39.10	40.83	36.56
Lanark	848	205	32.90	33.67	32.65	32.74
Linlithgow	9,198	1,685	41.67	44.98	44.21	43.21
Nairn	7,074	2,114	26 77	33.28	31.36	30.01
Orkney	12,786	3,606	28 [illegible]	32.98	33 12	32.32
Peebles	1,125	273	32.96	34.02	31.97	32.27
Perth	22,196	5,544	32.63	37.79	37.45	36.57
Renfrew	241	50	38.56	39.69	36.00	39.56
Ross and Cromarty	26,763	7,307	29.30	31.72	32.01	31.00
Roxburgh	40,858	9,616	33.09	28.40	37.60	36.11
Selkirk	1,343	316	34.01	35 31	33.00	32.46
Shetland	2.189	764	22.93	25.49	27.91	25.81
Stirling	4,545	974	37.33	46.03	36.52	40.66
Sutherland	1,847	475	31.10	34.17	33.20	33.25
Wigtown	1.037	206	40.28	40.13	40.73	38 08
Total	628,131	149,346	33.65	38.04	37.15	36.13

OATS.

Counties	Total Produce in 1915.	Acreage in 1915.	Yield per acre. 1915.	Yield per acre. 1914.	Yield per acre. 1913.	Average of the Ten Years, 1905-1914.
	Qrs.	Acres.	Bush.	Bush.	Bush.	Bush.
Aberdeen	909,265	194,564	37.39	39.22	36.62	36.73
Argyll	71,664	16,818	34.10	36.24	36.37	33.82
Ayr	271,894	41,912	51.90	49.98	47.70	48.47
Banff	234,090	50,032	37.42	40.25	41.01	38.75
Berwick	157,149	33,128	37.95	39.83	37.32	37.45
Bute	23,547	4,657	40.45	37.26	38.11	35.87
Caithness	124,108	30,828	32.21	32.26	37.03	31.41
Clackmannan	14.027	3,139	35.75	36.55	37.71	38.11
Dumbarton	38,159	6,859	44 54	43.63	42.67	41.24
Dumfries	198,588	42,102	37.65	36.87	37.08	34.66
Edinburgh	122,815	21,245	46.25	45.75	39.81	42.28
Elgin or Moray	149,582	26.196	45.68	44.99	44.84	43.65
Fife	231.610	43,465	42.69	42.14	36.42	38.60
Forfar	348.896	53,916	51.77	48.72	47.57	47.86
Haddington	115,081	18,858	48.82	51.46	42.79	44.78
Inverness	105,670	29,813	28.86	31.34	32.51	29.70
Kincardine	144,689	29,786	38.86	37.90	38.69	38.51
Kinross	28,792	6.447	35.73	32.63	30.08	33.30
Kirkcudbright	117.685	25,219	37.33	35.92	36.68	36.65
Lanark	175,460	37,487	37.44	36.46	34.33	36.61
Linlithgow	62,370	10,575	47.18	49.10	42.54	43.59
Nairn	25,491	6,488	31.43	36.82	32.34	33.30
Orkney	115,457	33,412	27.64	32.96	30.08	29.94
Peebles	30,568	7,065	34.61	36.57	31.09	33.22
Perth	401,605	68,477	46.92	45.73	40.07	39.40
Renfrew	59,104	10,405	45.44	44.62	47.04	43.54
Ross and Cromarty	151,235	32,596	37.12	37.22	36.92	35.07
Roxburgh	138,039	29,082	37.97	42.80	39.36	38.24
Selkirk	20,484	4,394	37.29	35.73	38.00	35.30
Shetland	18,395	6,575	22.38	25.50	29.58	26.60
Stirling	86,081	18,506	37.60	43.63	40.96	39.83
Sutherland	29,842	7,720	30.92	33.88	31.87	35.49
Wigtown	162.782	30,785	42.30	37.18	36.79	38.90
Total	4,885,190	982,601	39.77	40.18	38.40	37.99

* Average of 7 years only. † Crop failed. ‡ Average of 6 years only.

Table No. 3.—Total Produce of Beans, Peas, and Potatoes, Acreage and Yield per Acre in the Year 1915, compared with the Yield for the Years 1914 and 1913, and the Average of the Ten Years, 1905-1914, in each County of Scotland.

Counties.	Beans. Total Produce in 1915.	Beans. Acreage in 1915.*	Beans. Yield per acre. 1915.	Beans. Yield per acre. 1914.	Beans. Yield per acre. 1913.	Beans. Average of the Ten Years, 1905-1914.
	Qrs.	Acres.	Bush.	Bush.	Bush.	Bush.
Aberdeen	25	6	33.92	22.52	23.96	23.10
Argyll	109	32	27.34	24.79	24.16	23.66
Ayr	3,652	823	35.49	32.22	35.42	35.92
Banff	211	65	25.06	34.52	32.32	30.65
Berwick	1,578	470	31.97	35.35	35.43	35.60
Bute	135	42	25.73	23.59	24.94	24.15
Caithness	..	..	..	..	..	—
Clackmannan	1,330	226	47.09	47.22	41.28	42.35
Dumbarton	116	28	33.20	29.25	26.00	29.15
Dumfries	..	..	..	35.00	34.75	31.33
Edinburgh	14	3	36.17	36.67	28.89	32.88
Elgin or Moray	35	9	31.37	32.00	24.00	27.74
Fife	1,653	339	39.00	42.23	39.43	37.35
Forfar	235	47	40.00	40.00	34.00	33.06
Haddington	607	149	32.57	39.01	32.91	35.58
Inverness	..	..	..	28.00	26.00	24.22
Kincardine	86	20	34.40	34.00	32.96	33.36
Kinross	..	..	..	40.00	40.00	38.46
Kirkcudbright	85	18	37.83	37.60	44.27	38.71
Lanark	456	119	30.62	29.85	29.72	30.92
Linlithgow	334	74	36.11	38.55	32.91	35.81
Nairn	..	..	..	..	..	—
Orkney	..	..	..	..	..	..
Peebles	..	..	..	..	..	—
Perth	3,577	843	33.95	29.53	33.61	30.99
Renfrew	375	72	41.67	40.34	44.96	39.35
Ross and Cromarty	28	7	32.00	38.00	36.00	27.95
Roxburgh	602	139	34.65	31.05	30.58	33.22
Selkirk	27	6	36.00	30.00	30.00	—
Shetland	..	..	..	..	..	..
Stirling	8,002	1,688	37.92	47.29	43.54	43.85
Sutherland	..	..	..	..	..	—
Wigtown	846	157	43.11	39.03	36.51	35.86
Total	24,418	5,382	36.29	38.45	37.37	36.73

Counties.	Peas. Total Produce in 1915.	Peas. Acreage in 1915.‖	Peas. Yield per acre. 1915.	Peas. Yield per acre. 1914.	Peas. Yield per acre. 1913.	Peas. Average of the Ten Years, 1905-1914.
	Qrs.	Acres.	Bush.	Bush.	Bush.	Bush.
Aberdeen	122	37	26.46	20.23	20.95	18.38
Argyll	..	..	..	24.60	25.00	†23.54
Ayr	20	4	39.00	38.00	..	‡34.96
Banff	54	19	22.76	26.00	25.38	23.44
Berwick	25	9	22.22	26.67	26.33	§24.65
Bute	..	..	..	25.00	24.40	23.50
Caithness	..	..	..	..	..	..
Clackmannan	..	..	..	..	..	—
Dumbarton	..	..	..	..	..	**29.81
Dumfries	..	..	..	..	32.00	**27.45
Edinburgh	20	5	31.20	32.70	28.67	31.24
Elgin or Moray	23	9	20.89	20.00	24.92	22.20
Fife	11	3	30.00	36.00	..	§30.67
Forfar	4	1	30.00	31.50	..	§30.94
Haddington	4	1	30.00	36.54	39.47	35.02
Inverness	21	7	24.00	..	25.00	§23.69
Kincardine	..	..	..	24.75	31.38	29.49
Kinross	..	..	..	..	..	..
Kirkcudbright	..	..	..	..	..	‡22.56
Lanark	12	4	24.31	..	22.29	§21.34
Linlithgow	7	2	30.00	..	..	‡32.18
Nairn	17	6	23.00	24.60	24.67	27.29
Orkney	..	..	..	..	..	..
Peebles	7	2	30.00	..	30.00	§29.94
Perth	6	2	22.00	12.00	..	§18.55
Renfrew	..	..	..	..	..	—
Ross and Cromarty	28	9	24.67	26.21	24.00	20.59
Roxburgh	7	2	29.00	25.00	30.00	29.47
Selkirk	4	1	32.00	..	..	—
Shetland	..	..	..	..	..	—
Stirling	10	3	27.29	40.00	28.00	35.32
Sutherland	3	1	21.00	23.00	23.00	§23.52
Wigtown	..	..	..	.	..	—
Total	405	127	25.54	24.27	24.69	27.42

Counties.	Potatoes. Total Produce in 1915.	Potatoes. Acreage in 1915.	Potatoes. Yield per acre. 1915.	Potatoes. Yield per acre. 1914.	Potatoes. Yield per acre. 1913.	Potatoes. Average of the Ten Years, 1905-1914.
	Tons.	Acres.	Tons.	Tons.	Tons.	Tons.
Aberdeen	50,293	7,211	6.97	6.53	6.55	5.76
Argyll	20,181	3,457	5.84	6.03	5.80	5.43
Ayr	88,155	9,822	8.98	8.06	9.27	8.90
Banff	10,634	1,817	5.85	7.16	7.27	6.59
Berwick	16,940	2,659	6.37	7.51	7.19	6.94
Bute	7,545	1,024	7.37	6.64	6.77	6.30
Caithness	7,223	1,441	5.01	4.60	5.06	4.66
Clackmannan	2,865	404	7.09	9.35	7.31	7.65
Dumbarton	19,212	2,476	7.76	8.47	8.47	7.82
Dumfries	29,559	3,815	7.75	7.34	6.78	6.64
Edinburgh	53,884	7,118	7.57	8.36	6.82	7.69
Elgin or Moray	11,438	1,862	6.14	6.93	6.34	6.27
Fife	93,739	16,608	5.64	6.89	5.69	5.83
Forfar	122,796	17,069	7.19	7.36	6.05	6.76
Haddington	58,745	8,664	6.78	8.29	7.09	7.41
Inverness	21,691	5,467	3.97	3.80	3.77	3.88
Kincardine	22,439	3,734	6.01	6.14	5.89	5.51
Kinross	6,113	942	6.49	9.55	8.11	7.38
Kirkcudbright	12,991	1,756	7.40	6.48	6.04	5.93
Lanark	44,295	5,824	8.32	9.03	7.44	7.62
Linlithgow	20,933	2,620	7.99	8.68	6.87	7.59
Nairn	1,415	283	5.00	5.00	4.51	4.65
Orkney	13,975	2,590	5.40	4.89	7.06	5.45
Peebles	2,658	383	6.94	8.36	6.22	6.76
Perth	112,504	16,196	6.95	7.51	6.15	6.97
Renfrew	24,418	3,223	7.58	6.86	9.07	7.22
Ross and Cromarty	34,867	6,497	5.37	3.95	5.40	4.15
Roxburgh	8,469	1,248	6.79	5.88	6.14	6.10
Selkirk	1,211	184	6.58	6.34	5.00	5.58
Shetland	9,853	2,481	3.97	5.27	5.00	4.46
Stirling	24,035	3,353	7.17	8.10	8.24	7.67
Sutherland	6,665	1,316	5.06	5.07	5.08	5.09
Wigtown	10,340	1,349	7.66	8.85	7.50	7.17
Total	972,084	144,398	6.73	7.07	6.51	6.49

* Exclusive of a certain acreage, not ascertainable, the produce of which was cut or picked green.
‖ Exclusive of 538 acres, the produce of which was cut or picked green.
† Average of 6 years only.
§ Average of 9 years only.
‡ Average of 8 years only.
** Average of 7 years only.

TABLE No. 4.—TOTAL PRODUCE of TURNIPS (including SWEDES) and MANGELS, ACREAGE and YIELD per Acre in the Year 1915, compared with the YIELD for the Years 1914 and 1913, and the AVERAGE of the Ten Years, 1905-1914, in each COUNTY of SCOTLAND.

Counties.	Turnips and Swedes.						Mangels.					
	Total Produce in 1915.	Acreage in 1915.	Yield per Acre.			Average of the Ten Years, 1905-1914.	Total Produce in 1915.	Acreage in 1915.	Yield per Acre.			Average of the Ten Years, 1905-1914.
			1915.	1914.	1913.				1915.	1914.	1913.	
	Tons.	Acres.	Tons.	Tons.	Tons.	Tons.	Tons.	Acres.	Tons.	Tons.	Tons.	Tons.
Aberdeen	1,416,150	84,131	16.83	12.79	15.99	15.58	161	10	16.10	18.00	..	*12.65
Argyll	98,408	5,528	17.80	16.53	16.43	15.29	352	23	15.30	15.09	15.43	11.82
Ayr	148,954	7,111	20.95	21.20	20.97	20.28	12,546	510	24.60	24.62	22.52	21.78
Banff	362,472	20,643	17.56	10.75	17.72	16.35	22	1	22.00	23.00	10.71	11.86
Berwick	499,781	24,227	20.63	15.25	17.48	18.88	4,257	242	17.59	17.38	14.85	19.45
Bute	20,710	1,241	16.69	17.65	18.26	16.76	141	9	15.67	16.47	17.08	16.61
Caithness	227,087	12,050	18.85	15.58	18.04	18.34	..	..	..	..	..	..
Clackmannan	11,698	738	15.84	13.26	14.52	18.11	14	1	14.00	13.00	10.00	9.50
Dumbarton	29,759	1,391	21.39	21.45	21.51	20.09	223	11	20.27	18.75	21.00	17.86
Dumfries	273,372	16,055	17.03	12.72	16.19	14.66	8,465	385	*21.99	21.38	19.82	16.81
Edinburgh	198,160	9,557	20.73	16.54	18.57	18.68	1,433	66	21.71	23.96	21.52	21.86
Elgin or Moray	262,993	14,002	18.78	16.27	19.30	18.33	562	27	20.81	24.67	19.69	18.44
Fife	381,752	21,841	17.48	15.90	16.80	15.56	821	58	14.16	12.09	12.00	10.90
Forfar	682,585	31,387	21.75	19.00	21.31	19.41	494	20	24.70	23.67	20.86	20.50
Haddington	281,300	13,936	20.19	15.78	17.74	18.77	7,770	360	21.58	24.16	19.09	20.29
Inverness	139,418	9,665	14.43	13.69	14.85	15.93	28	2	14.00	†—	14.43	15.35
Kincardine	247,280	15,977	15.48	12.78	15.38	13.74	..	..	..	..	15.00	—
Kinross	40,944	2,394	17.10	14.24	15.80	14.28	54	3	18.00	..	..	—
Kirkcudbright	182,929	10,481	17.45	12.04	16.17	16.29	3,039	143	21.25	19.80	17.91	19.85
Lanark	186,991	9,438	19.81	21.07	18.82	17.85	130	18	7.22	5.46	5.38	7.47
Linlithgow	70,072	3,159	22.18	15.43	18.70	18.45	336	12	28.00	29.67	26.57	20.45
Nairn	57,442	3,876	14.82	13.82	15.71	14.95	182	13	14.00	..	..	‡15.26
Orkney	157,677	13,906	11.34	11.51	10.77	10.12	..	..	..	..	..	..
Peebles	63,293	3,430	18.45	18.94	19.61	19.23	90	5	18.00	..	..	§19.17
Perth	482,760	25,237	19.13	18.08	16.07	17.78	482	28	17.21	20.52	15.31	16.98
Renfrew	36,930	2,037	18.13	19.13	18.06	17.74	328	19	17.26	17.50	17.78	15.15
Ross and Cromarty	248,522	14,814	16.78	14.48	15.80	13.12	471	25	18.84	14.61	16.24	13.69
Roxburgh	290,010	19,234	15.08	10.48	16.26	15.43	2,333	108	21.60	24.51	22.27	17.73
Selkirk	42,436	2,374	17.88	9.53	14.00	14.37	..	..	..	..	18.00	—
Shetland	14,064	1,053	13.36	12.00	13.47	12.41	..	..	..	..	..	..
Stirling	100,926	3,882	26.00	27.20	22.72	22.92	410	17	24.12	28.50	21.14	21.74
Sutherland	46,831	2,852	16.42	12.25	14.90	14.07	..	..	..	..	..	—
Wigtown	229,091	13,348	17.16	11.46	16.50	16.93	10,426	387	26.94	22.63	21.80	20.43
Total	7,532,792	420,995	17.89	14.66	16.96	16.49	55,570	2,503	22.20	21.84	19.84	18.95

* Average of 9 years only. † Crop failed. ‡ Average of 8 years only. § Average of 6 years only.

TABLE No. 5.—TOTAL PRODUCE OF HAY from Ryegrass and other Rotation Grasses and Clover, also Total from Permanent Grass, ACREAGE, and YIELD per Acre in the Year 1915, compared with the YIELD for the Years 1914 and 1913, and the AVERAGE of the Ten Years, 1905-1914, in each COUNTY of SCOTLAND.

Counties.	From Clover, Sainfoin, and Grasses.						From Permanent Grass.					
	Total Produce in 1915.	Acreage in 1915.	Yield per Acre			Average of the Ten Years, 1905-1914.	Total Produce in 1915.	Acreage in 1915.	Yield per Acre.			Average of the Ten Years, 1905-1914.
			1915.	1914.	1913.				1915.	1914.	1913.	
	Tons.	Acres.	Cwts.	Cwts.	Cwts.	Cwts.	Tons.	Acres.	Cwts.	Cwts.	Cwts.	Cwts.
Aberdeen	63,902	47,255	27.05	23.21	26.90	27.93	1,568	1,307	23.99	22.05	21.72	20.51
Argyll	15.000	11,343	26.44	29.51	30.22	29.39	21,939	15,447	28.41	30.72	33.17	32.60
Ayr	38,860	26,399	29.44	31.20	34.13	32.50	43,522	21,620	40.26	41.43	43.32	43.22
Banff	13,093	9,606	27.26	28.05	29.00	29.15	531	608	17.49	17.31	18.71	15.87
Berwick	13,072	9,541	27.40	30.46	34.65	34.43	2,246	2,175	20.66	22.27	24.81	25.81
Bute	3,920	2,373	33.03	35.34	36.89	36.25	577	372	31.07	33.75	34.82	35.82
Caithness	8,226	9,333	17.63	19.74	22.56	19.71	379	860	8.82	10.40	10.96	12.21
Clackmannan	3,082	1,491	41.34	40.21	41.26	41.40	3,122	1,366	45.71	46.47	46.50	37.07
Dumbarton	9,096	5,831	31.20	35.09	38.69	34.76	3,800	2,132	35.64	33.86	37.51	33.72
Dumfries	24,392	18.992	25.69	26.12	29.05	23.03	24,700	19.031	25.96	28.17	31.02	27.47
Edinburgh	20.535	11,508	35.69	47.11	46.72	55.20	4,692	3,002	31.26	37.03	32.76	33.57
Elgin or Moray	8,311	5,635	29.50	30.03	30.68	31.50	458	385	23.78	25.28	24.49	23.95
Fife	42,544	25,615	33.22	37.39	39.54	35.03	6,127	3,528	34.74	32.29	37.31	29.57
Forfar	29.904	21,237	28.16	33.81	42.61	34.66	2,233	1,766	25.28	26.25	33.17	23.85
Haddington	16,775	10,014	33.50	46.88	48.54	53.91	1,530	1,014	30.17	30.87	32.68	31.87
Inverness	10,439	11,425	18.27	19.13	20.96	23.29	5,998	5,810	20.65	18.40	17.67	19.78
Kincardine	14,016	12,822	21.86	29.40	30.30	26.95	501	608	16.48	22.51	25.11	15.37
Kinross	4,387	2,697	32.54	33.89	33.54	33.84	1,283	740	34.66	34.92	38.51	33.01
Kirkcudbright	10,599	9,106	23.28	24.46	30.02	27.05	14,552	12,425	23.42	24.43	28.34	26.17
Lanark	43,623	31,976	27.29	31.36	33.15	34.21	16,535	13,441	24.60	29.52	31.61	32.06
Linlithgow	11,937	6,969	34.26	40.62	41.16	53.63	2,419	1,403	34.48	38.06	40.64	34.27
Nairn	1,291	1.593	16.21	17.25	20.21	18.93	56	80	14.00	12.52	15.59	14.73
Orkney	7,692	9,287	16.57	19.49	24.19	19.39	210	512	8.25	9.87	10.25	10.02
Peebles	2,588	2,213	23.39	33.16	35.09	34.62	2,430	1,708	28.45	32.67	33.61	31.26
Perth	44,482	31,339	28.39	39.68	35.01	29.86	14,651	12,156	24.10	28.10	29.13	23.92
Renfrew	21,876	10,366	42.21	37.35	38.29	38.01	12,195	6,385	38.20	36.02	42.31	37.33
Ross and Cromarty	12,993	12,832	20.25	19.80	20.96	20.18	1,797	2,326	15.46	14.57	14.93	12.61
Roxburgh	10,167	7,699	26.41	31.20	35.19	31.79	8,006	6,367	25.14	29.52	32.53	27.93
Selkirk	1,268	1,111	22.83	36.89	36.00	33.76	2,490	1,758	28.33	26.14	28.60	26.28
Shetland	1,527	1,352	22.60	28.68	25.65	21.92	1,197	1,192	20.09	25.60	19.18	17.56
Stirling	22,946	11,683	39.28	34.87	38.92	35.58	13,754	6,993	39.34	33.40	39.71	33.68
Sutherland	3,446	4,378	15.74	18.74	19.78	17.63	965	1,370	14.09	17.13	18.13	15.41
Wigtown	7,040	5,079	27.72	30.28	38.46	34.56	5,782	4,798	24.10	34.82	36.24	25.86
Total	543,029	390,105	27.84	30.82	33.16	31.94	222,245	154,685	28.74	30.68	32.94	29.60

TABLE No. 6.—NUMBER OF HORSES, CATTLE, SHEEP, AND PIGS IN EACH COUNTY OF SCOTLAND AS RETURNED ON JUNE 4, 1916.

Counties.	Horses (including Ponies).						Cattle.						Sheep			Pigs.
	Used solely for Agriculture, &c *	Stallions.†	Unbroken Horses.		Other Horses.	Total.	Cows in Milk.	Cows in Calf, but not in Milk.	Heifers in Calf.	Other Cattle.		Total.	1 Year Old and above.	Under 1 Year.	Total.	
			1 Year & above	Under 1 Year.						2 Years & above.	Under 2 Years.					
1. Aberdeen	20,677	108	6,169	2,701	2,788	32,443	37,186	2,761	2,624	46,317	88,118	177,006	122,389	97,287	219,676	11,419
2. Argyll	3,882	41	1,264	551	626	6,364	17,937	2,380	1,813	10,707	26,115	58,952	541,620	276,176	817,796	5,623
3. Ayr	6,685	73	1,675	779	1,595	10,807	44,077	6,328	8,564	11,704	43,518	114,791	217,173	148,559	365,732	13,614
4. Banff	5,946	26	1,886	891	698	9,447	11,012	803	652	7,762	26,015	46,244	40,051	27,563	67,614	2,805
5. Berwick	3,793	17	701	185	558	5,254	2,426	225	442	6,537	10,171	19,801	167,173	161,746	328,919	3,714
6. Bute	868	3	225	80	116	1,292	2,860	335	416	1,322	4,664	9,597	26,697	14,627	41,324	866
7. Caithness	3,913	25	1,027	529	368	5,862	6,251	574	336	2,086	11,669	20,916	86,146	61,547	147,693	1,969
8. Clackmannan	513	9	153	65	55	795	999	83	137	754	1,524	3,497	9,188	6,772	15,960	582
9. Dumbarton	1,236	6	281	112	254	1,889	5,948	1,053	839	2,259	4,838	14,937	46,139	28,694	74,833	953
10. Dumfries	4,700	37	1,546	626	1,304	8,213	17,523	1,857	5,152	11,365	33,052	68,949	323,777	234,657	558,434	8,492
11. Edinburgh	3,041	16	465	166	947	4,635	9,072	721	562	3,290	5,134	18,779	103,205	75,040	178,245	11,186
12. Elgin	3,360	15	899	498	402	5,174	5,648	363	313	4,053	12,511	22,888	31,180	18,477	49,657	1,893
13. Fife	6,646	38	1,459	615	1,440	10,198	9,978	1,154	1,262	14,984	19,534	46,912	61,494	52,012	113,506	7,059
14. Forfar	7,253	18	1,145	433	1,092	9,941	9,721	809	576	18,009	19,318	48,433	100,162	74,147	174,309	7,350
15. Haddington	2,928	13	321	132	340	3,734	1,612	152	275	4,463	3,779	10,281	73,383	57,849	131,232	1,843
16. Inverness	5,913	44	1,351	714	574	8,596	17,070	2,445	970	5,036	20,859	46,380	352,822	169,620	522,442	1,657
17. Kincardine	3,606	4	811	283	504	5,208	5,482	373	389	7,036	13,166	26,446	28,906	20,924	49,830	2,478
18. Kinross	722	2	237	81	112	1,154	1,072	127	202	1,296	4,097	6,794	18,604	15,114	33,718	724
19. Kirkcudbright	3,221	105	1,075	423	777	5,601	15,708	846	3,823	10,361	23,560	54,298	223,926	153,238	377,164	12,694
20. Lanark	5,997	90	1,387	679	1,341	9,494	28,941	5,664	4,800	11,032	26,272	76,709	147,779	98,497	246,276	8,045
21. Linlithgow	1,548	12	431	190	292	2,473	3,916	631	654	2,442	4,166	11,809	12,273	7,617	19,890	1,225
22. Nairn	862	4	249	120	127	1,362	1,817	141	82	454	3,853	6,347	12,144	5,247	17,391	503
23. Orkney	4,758	30	1,146	717	737	7,388	8,783	1,087	726	4,352	17,467	32,415	19,102	17,983	37,085	1,855
24. Peebles	731	8	163	64	154	1,120	1,592	185	370	1,432	3,584	7,163	115,756	86,322	202,078	549
25. Perth	9,027	65	2,108	844	1,480	13,524	14,223	1,184	1,543	15,378	37,951	70,279	408,201	236,137	644,338	7,550
26. Renfrew	2,174	29	459	210	545	3,417	11,293	2,533	1,779	2,593	7,916	26,114	26,055	18,107	44,162	1,652
27. Ross and Cromarty	5,164	17	1,204	508	607	7,500	14,603	1,790	1,145	6,448	18,691	42,677	174,487	91,827	266,314	3,696
28. Roxburgh	3,141	17	442	176	769	4,545	3,752	365	595	5,624	9,784	20,120	285,332	239,095	524,427	3,109
29. Selkirk	466	..	74	19	109	668	1,010	96	77	481	1,722	3,386	103,055	74,480	177,535	468
30. Shetland	2,439	131	644	476	2,133	5,823	5,387	831	398	2,034	5,770	14,420	106,513	51,646	158,159	455
31. Stirling	3,060	44	861	368	606	4,939	8,399	1,763	1,593	7,804	13,720	33,279	75,786	51,648	127,434	2,381
32. Sutherland	1,762	7	349	131	265	2,514	4,097	715	312	1,149	4,501	10,774	139,653	62,608	202,261	535
33. Wigtown	3,431	77	1,173	538	697	5,916	24,413	682	1,891	8,690	19,305	54,981	72,342	48,088	120,430	17,446
Total	133,463	1,131	33,380	14,904	24,412	207,290	354,408	41,056	45,312	239,254	586,344	1,226,374	4,272,513	2,783,351	7,055,864	146,390

* Including Mares kept for breeding

† Above two years old used, or intended to be used, for service.

TABLE NO. 7.—QUANTITY AND VALUE OF CORN, &c., imported into the United Kingdom in the undermentioned Years.

[*From Trade and Navigation Returns.*]

	Quantities.			Values.		
	1914	1915.	1916.	1914.	1915.	1916.
Wheat from—	Cwt.	Cwt.	Cwt.	£	£	£
Russia	7,234,827	796,300	12,500	2,825,714	464,149	7,744
Germany	977,500	..	..	365,327	..	..
Turkey	39,300	26,000	..	10,295	18,755	.
Roumania	343,500	..	..	134,763	..	..
United States	34,220,166	41,649,000	64,544,100	14,876,510	26,533,103	45,996,513
Chile	50,700	..	116,900	21,033	..	93,110
Argentine Republic	6,497,760	12,156,000	4,495,700	2,581,389	8,609,500	3,421,712
British East Indies	10,708,900	13,956,500	5,611,900	4,922,803	8,845,461	4,458,620
Australia	12,113,400	180,300	3,699,620	5,159,137	94,167	2,759,641
New Zealand	8,500	..	30,500	3,726	..	26,501
Canada	31,457,090	19,725,300	21,549,200	13,717,995	12,625,344	15,243,758
Other countries	275,100	178,500	8,100	115,387	116,020	3,776
Total	103,926,743	88,667,900	100,068,520	44,734,079	57,306,499	72,011,375
Wheat, meal, and flour, from—						
Germany	215,707	..	..	107,547	..	..
Belgium	37,240	..	..	15,317	..	..
France	363,600	65,600	5	152,842	33,891	5
Austria-Hungary	56,255	.	..	44,339	..	.
United States	5,557,908	6,740,410	5,182,049	3,146,789	5,307,158	4,896,727
Argentine Republic	57,800	89,000	17,200	20,613	52,990	11,648
Australia	248,900	1,800	501,360	130,974	1,300	457,604
Canada	3,227,033	3,361,260	4,227,611	1,789,383	2,735,137	3,669,715
Other countries	295,780	224,100	32,108	141,244	180,382	32,485
Total	10,060,223	10,482,170	9,960,333	5,549,048	8,310,853	8,568,134
Barley	16,044,422	12,291,685	15,823,700	5,660,312	6,029,866	10,418,138
Oats	14,156,715	15,640,100	12,602,600	4,674,417	8,488,539	6,597,577
Peas	983,694	1,099,953	991,121	546,470	872,407	1,290,024
Beans, other than Haricot	1,441,559	1,142,810	1,116,725	502,928	534,139	600,732
Indian corn or maize	39,040,747	48,581,300	34,154,210	11,760,912	18,901,825	19,896,157
Indian corn meal	232,469	247,396	418,643	78,895	112,571	246,713
Oatmeal	609,992	890,481	973,333	502,938	878,686	986,855
Offals of corn and grain, including rice-meal	4,890,983	8,249,171	3,774,653	1,081,163	2,463,735	1,637,343
Rice, exclusive of rice-meal—						
From Brit. East Indies	3,178,663	5,817,565	6,717,064	1,544,369	3,141,874	5,268,141
From other countries	2,238,956	4,175,474	1,942,658	1,081,306	2,200,547	1,653,601
Other kinds of grain and corn	1,643,175	1,943,485	2,260,060	769,109	1,447,346	2,065,084
Other kinds of meal and flour	195,636	102,150	54,234	96,919	76,058	52,583
Total of corn, &c.	..	..		78,582,865	110,764,945	131,377,457

TABLE NO. 8.—RETURN OF THE AVERAGE PRICES OF WOOL in the Years 1915 and 1916.

Years.	Australian.	South African.	English Fleeces.
	Per lb.	Per lb.	Per lb.
	s. d.	s. d.	s. d. s. d.
1915	0 11$\frac{1}{8}$	0 9$\frac{1}{8}$	1 5$\frac{1}{4}$ to 1 9$\frac{1}{8}$
1916	1 3$\frac{3}{8}$	1 0$\frac{3}{8}$	1 7$\frac{3}{4}$ " 2 0$\frac{1}{2}$

Table No. 9.—Quantities and Values of Corn, Meat, Food Products, and Articles affecting Agriculture, imported into the United Kingdom in the Year 1916, with the Corresponding Figures for 1914 and 1915.

[*From Trade and Navigation Returns.*]

	Quantities.			Values.		
	1914.	1915.	1916.	1914.	1915.	1916.
Animals, Living:—	No.	No.	No.	£	£	£
Cattle	2,234	.	..	46,295	..	..
Sheep and lambs	1,707		..	3,000	..	..
Swine	.	.	..	..	..	..
Total value			..	49,295	..	..
Grain, Flour, &c.:—	Cwt.	Cwt.	Cwt.	£	£	£
Wheat	103,926,748	88,667,900	100,068,520	44,734,079	57,806,499	72,011,875
Wheat meal and flour	10,060,223	10,482,170	9,960,333	5,549,048	8,310 858	8,568,134
Barley	16,041,422	12,291,665	15,823,700	5,660,812	6,029 866	10,418,188
Oats	14,156,715	15,640,100	12,602,600	4,674,417	8,488,539	6,597,577
Peas	983,694	1,199,953	991,121	546,470	872,407	1,290,024
Beans	1,441,559	1,142,810	1,116,725	502,928	584,189	690,732
Maize or Indian corn	39,040,747	48,581,300	34,154,210	11,760,912	18,901,825	19,896,157
Maize meal	232,469	247,396	418,643	78,895	112,571	246,718
Oatmeal	600,992	890,481	973,333	502,938	878,686	986,855
Offals of corn and grain, including rice-meal	4,890,983	8,249,171	3,774,653	1,081,163	2,468,735	1,637,848
Rice, exclusive of rice-meal—						
From British East Indies	3,178,663	5,817,565	6,717,064	1,544,369	3,141,874	5,268,141
From other countries	2,238,956	4,175,474	1,942,658	1,081,306	2,200,547	1,653,601
Other kinds of grain & corn	1,643,175	1,943,485	2,260,060	769,109	1,447,346	2,065,084
Other kinds of meal and flour	195,636	102,150	54,284	96,919	76,058	52,588
Total value		.	..	78,582,865	110,764,945	131,877,457
Meat:—	Cwt	Cwt.	Cwt	£	£	£
Beef, salted	29,841	67,991	65,512	65,262	180,436	215,334
*Beef	8,844,567	8,601,687	7,056,191	19,060,871	25,839,544	23,047,855
*Mutton	5,199,731	4,707,859	3,636,568	11,410,310	13,872,141	13,505,017
Bacon	5,098,080	6,523,377	7,435,955	18,225,568	25,441,460	34,381,717
Hams	838,830	1,480,458	1,554,836	3,063,078	5,280,816	6,841,430
Pork, salted (not bacon or hams)	261,141	106,892	41,478	302,477	214,875	135,422
*Pork	861,203	269,305	293,383	2,360,722	795,409	1,169,174
*Meat, unenumerated	813,757	774,234	704,668	1,693,984	1,796,161	1,928,927
" " salted	139,534	102,835	27,519	180,329	163,946	109,538
Meat, preserved, otherwise than by salting	995,211	2,037,657	1,884,749	5,112,291	11,652,460	10,876,892
*Rabbits (dead)	505,925	603,735	646,888	747,643	914,486	1,179,224
Total of dead meat	23,587,820	25,276,030	23,347,692	62,222,035	86,151,234	93,390,030
Dairy Produce:—	Cwt.	Cwt.	Cwt.	£	£	£
Butter	3,984,204	3,853,855	2,178,029	24,014,276	27,022,745	18,977,450
Margarine	1,529,219	2,052,183	2,752,866	3,977,361	5,751,258	8,983,007
Cheese	2,433,864	2,726,536	2,604,027	7,966,162	11,107,100	12,945,450
Total	7,947,287	8,632,574	7,534,922	35,957,799	43,881,098	40,905,907

* Fresh, Chilled, and Frozen.

TABLE No. 9—*Continued.*

	Quantities.			Values.		
	1914.	1915.	1916.	1914.	1915.	1916.
				£	£	£
POULTRY (alive or dead)	..	..	..	798,961	655,399	636,181
GAME (alive or dead)	..	..	..	144,765	32,458	32,276
EGGS	Gt. Hunds. 17,904,805	Gt. Hunds. 10,246,026	Gt. Hunds. 6,606,411	8,652,800	6,123,326	4,741,461
Total value	..	..	..	9,596,526	6,811,178	5,409,868
FRUIT, VEGETABLES, &c.:—	Cwt.	Cwt.	Cwt.	£	£	£
Apples	2,929,649	3,343,629	2,656,202	2,046,824	2,822,249	2,788,016
Cherries	167,966	27,334	14,140	239,468	49,705	27,852
Plums	207,680	137,776	61,735	289,096	192,698	118,176
Pears	409,871	210,537	160,591	364,894	259,045	242,062
Grapes	650,515	554,812	796,363	722,900	711,350	1,097,090
Oranges	5,108,049	6,006,062	5,875,611	2,323,235	2,636,096	3,085,518
Lemons	830,352	775,863	691,198	494,491	472,645	498,458
Unenumerated	248,295	184,696	265,488	253,466	219,439	275,285
Onions	Bushels. 7,513,513	Bushels. 7,477,598	Bushels. 6,843,247	1,480,773	1,789,547	2,062,149
Potatoes	Cwt. 3,332,164	Cwt. 2,170,717	Cwt. 1,803,174	1,535,515	1,187,846	1,526,481
Vegetables, unenumerated (raw)	..	..	..	475,714	318,382	233,840
Hops	97,306	200,337	148,407	558,741	798,512	714,518
Total value	..	..		10,785,117	10,957,514	12,618,903
OTHER ARTICLES:—	Cwt.	Cwt.	Cwt.	£	£	£
Lard	1,765,107	2,210,436	1,932,827	4,750,943	5,783,260	6,982,985
Wool, sheep and lambs'	Lb. 711,618,116	Lb. 926,380,086	Lb. 619,484,784	31,212,789	42,027,835	37,597,114
Wood and timber—	Loads.	Loads.	Loads.			
Hewn (pit-props or pit-wood)	2,476,854	2,168,631	2,021,277	3,259,346	4,786,361	6.908,091
Sawn or split, planed or dressed	4,625,249	4,646,366	3,686,287	14,952,951	21,950,587	27,748,443
Staves	93,439	109,377	82,011	556,066	707,888	804,907
Oilseed-cake (not sweetened)	Tons. 329,431	Tons. 425,113	Tons. 283,937	1,988,839	3,273,159	3,115,955
Seeds—						
Clover and grass	Cwt. 175,905	Cwt. 260,376	Cwt. 233,246	410,737	707,263	692,877
Cotton	Tons. 639,572	Tons. 494,585	Tons. 329,237	4,420,307	4,122,498	4,449,935
Flax or linseed	Qrs. 2,451,778	Qrs. 2,126,409	Qrs. 2,507,086	5,723,846	5,573,622	9,357,686
Rape	309,241	192,836	375,087	622,927	464,220	1,271,469
Soya beans	Tons. 71,161	Tons. 170,910	Tons. 65,364	593,190	1,428,281	960,856
Bones (whether burnt or not)	34,404	27,761	27,405	186,001	179,815	243,376
Guano	39,285	26,720	21,644	232,086	182,005	219,099
Basic slag	16,572	..	..	31,819	..	..
Nitrate of soda (cubic nitre)	171,910	131,520	20,896	1,721,138	1,498,068	361,619
Phosphate of lime and rock phosphate	562,242	374,639	333,871	970,337	704,749	888,605
Cotton, raw of 100 lb.	Centals. 18,641,333	Centals. 26,476,161	Centals. 21,710,022	55,350,626	64,671,628	84,729,677
Hemp	Tons. 127,085	Tons. 145,547	Tons. 143,891	3,486,684	4,814,492	6,802,391
Flax	87,126	84,700	86,653	4,148,120	5,945,717	7,620,621
Hides untanned—						
Dry	Cwt. 639,208	Cwt. 733,001	Cwt. 600,358	2,976,458	3,500,578	3,351,975
Wet	753,287	1,077,090	770,329	2,935,281	4,975,591	4,132,000
Petroleum	Gallons. 646,712,631	Gallons. 588,469,699	Gallons. 451,931,774	12,756,207	13,805,495	19,508,988

TABLE No. 10.—QUANTITY AND VALUE OF DEAD MEAT imported into the United Kingdom in the undermentioned Years.

	Quantities.			Values.		
	1914.	1915.	1916.	1914.	1915.	1916.
	Cwt.	Cwt.	Cwt.	£	£	£
BACON, from—						
Denmark	2,714,807	2,068,221	1,641,613	9,936,454	9,128,847	9,087,913
United States	1,522,958	3,529,599	4,004,410	5,857,458	12,752,834	16,848,826
Canada	342,286	864,185	1,594,114	1,224,462	3,324,511	7,443,584
Other countries	518,029	66,372	195,818	1,707,194	235,268	1,001,894
Total	5,098,080	6,528,377	7,435,955	18,225,568	25,441,460	34,381,717
BEEF (salted), from—						
United States	29,397	63,970	64,630	64,241	167,863	211,527
Other countries	444	4,021	882	1,021	12,573	3,807
Total	29,841	67,991	65,512	65,262	180,436	215,334
*BEEF (fresh and refrigerated)—						
United States	87,589	1,001,351	930,207	246,909	3,227,869	3,520,205
Uruguay	729,779	363,613	206,089	1,469,766	1,042,043	604,215
Argentine Republic	5,993,126	5,096,461	4,037,678	14,034,530	15,304,661	12,785,438
Australia	1,551,001	1,236,938	765,493	3,247,323	3,565,458	2,425,496
New Zealand	476,680	735,226	875,086	944,459	2,176,621	2,824,664
Denmark	1,343	354	..	4,487	1,075	..
Other countries	5,049	167,744	241,638	12,897	521,817	887,827
Total	8,844,567	8,601,687	7,056,191	19,960,371	25,839,544	23,047,855
HAMS, from—						
United States	774,805	1,364,024	1,493,606	2,827,350	4,859,895	6,572,170
Canada	58,985	115,966	60,205	217,814	418,112	264,151
Other countries	5,040	468	1,025	17,914	2,309	5,109
Total	838,830	1,480,458	1,554,836	3,063,078	5,280,316	6,841,430
*MEAT (unenumerated, fresh and refrigerated), from—						
Netherlands	276,791	150,023	11,078	656,525	356,053	29,824
United States	66,978	161,306	151,571	182,766	420,026	513,697
Argentine Republic	298,487	246,456	391,529	511,169	522,832	1,007,614
Other countries	311,035	316,284	178,014	523,853	661,196	487,380
Total	953,291	877,069	732,187	1,874,313	1,960,107	2,038,465
MEAT, preserved otherwise than by salting—						
Beef	803,402	1,770,777	1,616,756	4,239,570	10,818,953	9,421,664
Mutton	61,274	59,430	43,226	183,370	240,900	184,027
Other sorts	130,535	207,450	224,767	689,351	1,092,607	1,271,201
Total	995,211	2,037,657	1,884,749	5,112,291	11,652,460	10,876,892
*MUTTON (fresh and refrigerated)—						
Netherlands	148,045	48,838	16,504	387,335	128,413	68,082
Uruguay	35,160	39,107	20,834	64,750	99,198	76,381
Argentine Republic	1,145,583	781,735	768,259	2,390,810	2,093,923	2,885,754
Australia	1,326,055	1,254,493	261,352	2,800,707	3,390,715	914,562
New Zealand	2,377,334	2,422,806	2,287,377	5,435,128	7,669,945	8,413,428
Other countries	167,554	160,880	282,237	331,580	489,647	1,146,810
Total	5,199,731	4,707,859	3,636,563	11,410,310	13,872,141	13,505,017
PORK (salted, not Bacon or Hams), from—						
Denmark	211,941	37,340	..	185,986	36,056	..
United States	36,795	66,244	40,672	92,472	169,637	132,420
Other countries	12,405	3,308	806	24,019	9,182	3,002
Total	261,141	106,892	41,478	302,477	214,875	135,422
*PORK (fresh and refrigerated)—						
Netherlands	817,736	137,692	759	2,232,664	359,312	1,908
Belgium	11,425	..	..	32,651	..	..
United States	4,511	86,628	249,973	13,157	288,524	998,221
Other countries	27,531	44,985	42,601	82,250	147,578	169,045
Total	861,203	269,305	293,333	2,360,722	795,409	1,169,174
*RABBITS (dead), from—						
Belgium	15,838	..	..	43,881	..	..
Australia	391,371	506,866	601,720	539,064	754,648	1,085,938
New Zealand	84,877	88,138	41,062	124,882	133,902	81,669
Other countries	13,839	8,731	4,106	39,816	25,941	11,617
Total	505,925	603 735	646,858	747,043	914,486	1,179,224
Total of dead meat	23,587,820	25,276,030	23,347,692	62,222,035	86,151,234	93,890,080

* In the Official Returns from 1909 the imports are shown separately as "Fresh," "Chilled," and 'Frozen."

TABLE No. 11.—QUANTITIES AND VALUES OF BUTTER, MARGARINE, CHEESE, AND EGGS imported into the United Kingdom in each Year from 1914 to 1916 inclusive.

[*From Trade and Navigation Returns.*]

	Quantities.			Values.		
	1914.	1915.	1916.	1914.	1915.	1916.
BUTTER from—	Cwt.	Cwt.	Cwt.		£	£
Russia	616,380	1,017,507	34,542	3,382,411	6,371,012	212,846
Sweden	270,138	128,294	992	1,647,575	969,538	7,585
Denmark	1,749,072	1,327,100	1,134,801	11,038,637	10,221,398	10,378,070
Netherlands	183,999	44,544	36,202	1,144,181	313,868	336,478
France	273,819	352,090	130,249	1,674,155	2,275,676	974,743
United States	7,844	77,130	131,618	39,372	529,200	1,179,670
Argentine Republic	55,704	82,947	117,597	325,450	569,052	940,409
Victoria	204,716	106,024	81,032	1,174,663	748,484	693,218
New S. Wales	122,528	158,222	32,565	701,283	1,078,074	280,374
Queensland	106,694	107,173	26,913	574,883	722,800	222,328
New Zealand	357,920	374,898	331,162	2,100,958	2,693,808	2,727,645
Canada	3,128	24,401	101,531	18,496	167,442	855,586
Other countries	32,262	53,525	18,825	192,212	362,393	168,548
Total	3,984,204	3,853,855	2,178,029	24,014,276	27,022,745	18,977,450
MARGARINE from—	Cwt.	Cwt.	Cwt.	£	£	£
Netherlands	1,502,576	2,024,469	2,738,343	3,896,375	5,666,146	8,917,714
France	13,389	17,537	9,800	50,037	60,623	50,551
Other countries	13,254	10,177	4,723	30,949	24,484	14,742
Total	1,529,219	2,052,183	2,752,866	3,977,361	5,751,253	8,983,007
CHEESE from—	Cwt.	Cwt.	Cwt.	£	£	£
Netherlands	349,124	129,105	112,587	921,311	438,235	640,217
Italy	97,932	75,917	31,938	328,538	297,612	152,492
United States	31,390	459,793	274,687	104,925	1,887,816	1,305,932
Australia	18,157	20,542	1	57,584	91,729	4
New Zealand	742,419	709,326	667,214	2,432,117	3,081,465	3,352,195
Canada	1,167,778	1,315,177	1,505,018	4,025,950	5,241,789	7,432,179
Other countries	27,064	16,676	12,582	95,737	68,454	62,431
Total	2,433,864	2,726,536	2,604,027	7,966,162	11,107,100	12,945,450
EGGS from—	Great Hundreds.	Great Hundreds.	Great Hundreds.	£	£	£
Russia	6,870,827	3,074,156	734,525	2,914,085	1,749,822	423,949
Denmark	4,315,900	2,657,835	1,392,061	2,546,979	1,863,527	1,303,177
Netherlands	1,192,286	874,013	84,737	603,323	685,856	83,067
France	632,741	36	...	328,821	21	...
Italy	874,193	4,768	..	431,830	3,455	...
United States	493,229	627,896	779,716	290,254	387,212	591,202
Egypt	1,121,832	1,428,409	1,889,947	387,776	547,970	974,656
Canada	361,173	912,326	1,431,778	233,514	584,234	1,173,788
Other countries	2,042,624	666,587	293,647	916,218	351,229	191,562
Total	17,904,805	10,246,026	6,606,411	8,652,800	6,123,326	4,741,401

TABLE NO. 12.—NUMBER OF LIVE STOCK IN 1913, 1914, AND 1915, returned as entering the Markets at the Places scheduled under the Markets and Fairs (Weighing of Cattle) Act, 1891.

[*From Agricultural Statistics*, 1915.]

	Cattle.			Sheep.			Swine.		
	1913.	1914.	1915.	1913.	1914.	1915.	1913.	1914.	1915.
Aberdeen.	73,576	74,721	45,281	196,501	208,063	221,816	12,071	13,200	17,128
Dundee .	18,129	16,033	16,922	30,726	27,246	28,312	3,664	3,813	4,865
Edinburgh	70,742	63,742	66,168	230,135	217,528	215,472	6,848	7,006	9,205
Stirling .	73,144	59,364	69,588	230,964	246,610	244,783	3,789	4,260	4,998
Glasgow .	77,472	66,957	71,259	376,147	369,648	378,122	4,559	4,887	6,972
Perth . .	126,600	98,046	101,783	441,928	403,741	424,675	12,039	11,635	14,731
	439,663	378,862	370,996	1,506,401	1,472,836	1,508,188	42,970	44,801	57,899

TABLE NO. 13.—AVERAGE PRICES OF FAT CATTLE PER CWT. (LIVE WEIGHT) at the undermentioned Places in each Year from 1908 to 1915, together with the average Prices for Scotland, England, and Great Britain, compiled from the Returns received under the Markets and Fairs (Weighing of Cattle) Act, 1891.

	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Aberdeen .	33 6	34 5	35 10	34 7	38 9	38 4	39 0	
Dundee . .	33 5	34 0	35 8	34 0	38 1	37 0	37 9	
Edinburgh . .	36 5	37 2	38 7	36 10	41 2	39 10	40 7	52 4
Glasgow . . .	34 3	34 10	36 2	35 1	39 7	38 9	39 10	52 1
Perth . . .	37 0	37 11	40 3	37 10	42 2	40 7	41 3	54 4
SCOTLAND . . .	34 8	35 6	37 2	35 8	40 0	38 11	39 8	
ENGLAND . . .	34 2	34 8	36 0	35 0	37 9	38 11	39 8	
GREAT BRITAIN .	34 7	35 4	36 11	35 6	39 6	38 11	39 8	

TABLE No. 14.—NUMBER AND VALUE OF LIVE CATTLE, SHEEP, AND SWINE imported into the United Kingdom in the undermentioned Years. [*From Trade and Navigation Returns.*]

	Number.			Value		
	1914.	1915.	1916.	1914.	1915.	1916.
				£	£	£
CATTLE, from—						
Channel Islands .	2,174			42,027		
Canada . .						
United States		.		..		
Argentine Republic						
Other countries	60			4,268		
Total .	2,231			4[illegible]95		
SHEEP AND LAMBS, from—						
Canada						
United States	1,707			3,000		
Argentine Republic						
Other countries						
Total	1,707			3,000		
SWINE (not separately enumerated)						
TOTAL VALUE OF ANIMALS LIVING				49,295		

TABLE No. 15.—NUMBER OF HORSES, CATTLE, SHEEP, AND PIGS imported into Great Britain from Ireland in each of the Years 1910-1916.

	1910.	1911.	1912.	1913.	1914.	1915.	1916.
*HORSES.—							
Stallions .	277	228	287	265	188	276	272
Mares .	15,580	15,283	17,010	17,914	15,227	7,729	2,779
Geldings .	15,945	16,067	17,414	18,312	15,338	9,806	3,827
Total .	31,802	31,578	34,711	36,491	30,753	17,811	6,878
CATTLE Oxen, Bulls, and Cows:—							
Fat .	[illegible]59,415	269,527	336,559	354,734	455,444	363,272	423,783
Store .	548,391	390,041	193,922	692,228	448,703	440,995	442,745
Other cattle	12,324	8,789	8,851	8,152	6,096	9,459	9,398
Calves .	52,800	26,471	15,767	53,045	34,335	27,009	13,180
Total . .	867,930	694,828	555,099	1,108,159	944,578	840,735	889,056
SHEEP:—							
Sheep . . .	347,784	306,124	328,028	319,284	256,607	229,896	313,467
Lambs . .	381,557	348,073	290,631	336,416	280,932	259,495	323,270
Total . .	729,341	654,197	618,659	655,700	537,539	489,391	636,737
PIGS—							
Fat . .	301,576	323,574	253,165	187,422	146,458	171,963	263,989
Store . . .	22,479	18,766	12,076	12,874	1,464	7,093	14,158
Total . .	324,055	342,340	265,241	200,296	147,922	179,056	278,147

* Not including Army Horses.

EDINBURGH CORN-MARKET GRAIN TABLES for Wheat, Barley, Oats, and Beans, showing the Quantity offered for Sale, the Quantity Sold, the Highest, Lowest, and Average Prices; also the Bushel-weights of the Highest and Lowest Prices of each kind of Grain for every Market-day, likewise the Results for every Month, and the final Result for the year 1916.

WHEAT.

Date.	Quantity offered for Sale.	Quantity Sold.	Highest Price.	Lowest Price.	Average Price.	Table of Bushel-weights for Highest Price.	Table of Bushel-weights for Lowest Price.
1916 Jan.	Imp. qr.	Imp. qr.	s. d.	s. d.	s. d.	lb. lb.	lb. lb.
5	491	435	58 6	56 0	57 7	63	63
12	384	384	59 6	55 0	57 9	63	63
19	616	406	60 6	57 0	59 5	63	61
26	465	465	62 9	58 0	61 7	63	63
	1,956	1,690	59 7	56 5	59 2		
Feb.							
2	839	839	61 0	59 0	60 2	63	63
9	326	238	60 6	59 6	60 1	63	63
16	408	113	60 0	56 6	58 1	63	61
23	917	457	60 6	59 0	60 1	63	62
	2,490	1,647	60 9	58 11	60 0		
March							
1	750	635	59 6	57 0	58 2	63	63
8	643	489	59 6	57 6	58 8	63	63
15	583	379	58 0	56 6	57 3	63	62
22	720	710	54 0	51 0	53 8	63	63
29	750	535	54 0	51 0	53 1	63	62½
	3,446	2,748	54 9	54 8	55 11		
April							
5	75	..	..	..	..	..	..
12	247	72	55 6	52 6	54 0	63	63
19	612	612	56 3	54 6	55 6	63	62
26	..	.	..	.	..	..	..
	934	684	56 0	53 11	55 4		
May							
3	283	243	57 0	55 0	55 9	63	63
10	827	560	57 3	55 0	56 5	63	63
17	841	545	57 0	55 6	56 4	63	63
24	568	568	55 6	53 6	54 2	63	63
31	590	510	54 0	52 0	52 7	63	63
	3,109	2,426	55 10	53 6	55 0		
June							
7	680	625	50 6	49 0	49 11	63	63
14	517	327	49 6	47 6	48 8	63	63
21	1,211	771	46 0	43 0	45 1	63	63
28	478	465	46 0	44 6	45 1	63	63
	2,886	2,188	46 5	46 3	46 11		
July							
5	335	335	48 6	47 0	47 9	63	62 63
12	130	130	52 6	52 0	52 1	63	63
19	241	221	56 0	54 0	55 3	63	63
26	100	25	56 0	..	56 0	63	..
	806	711	52 3	49 5	51 2		

Wheat—*continued.*

Date.	Quantity offered for Sale.	Quantity Sold.	Highest Price.	Lowest Price.	Average Price.	Table of Bushel-weights for Highest Price.	Table of Bushel-weights for Lowest Price.
1916 Aug.	Imp. qr.	Imp. qr.	s. d.	s. d.	s. d.	lb. lb.	lb. lb.
2	656	461	57 0	56 0	56 11	63	63
9	265	265	61 0	58 6	60 5	63	63
16	712	662	63 6	60 0	62 6	63	63
23	575	420	64 0	61 6	63 5	63	63
30	356	356	64 6	62 0	63 9	63	63
	2,564	2,164	60 10	60 2	61 5		
Sept.							
6	130	130	66 0	59 0	62 9	63	61
13	14	14	63 0	..	63 0	63	..
20	100	100	66 6	62 8	65 8	63	62
27	89	24	56 6	56 3	56 5	61	61
	333	268	65 1	59 6	63 3		
Oct.							
4	262	257	65 0	51 6	61 2	63	57
11	72	62	70 0	60 0	65 10	63	62
18	183	163	71 0	57 0	67 6	63	60½
25	157	68	105 0	64 0	77 7	63	62
	674	550	71 7	56 2	65 7		
Nov.							
1	543	294	105 0	67 6	75 11	63	61½
8	553	279	105 0	70 0	75 8	63	63
15	804	532	84 0	70 0	75 0	63	63
22	813	88	75 0	71 3	73 9	63	63
29	204	120	80 0	72 0	75 4	63	63
	2,417	1,313	87 0	69 7	75 3		
Dec.							
6	205	151	75 0	60 0	73 7	63	58½
13	164	138	77 0	75 0	76 1	63	63
20	170	110	79 0	73 0	76 11	63	63
27	205	172	78 6	70 0	76 11	63	63
	744	571	77 2	72 5	75 10		
Result for year	22,359	16,060	59 7	55 1	58 5		

BARLEY.

Date.	Quantity offered for Sale.	Quantity Sold.	Highest Price.	Lowest Price.	Average Price.	Highest Price.	Lowest Price.
1916 Jan.							
5	78	78	56 0	55 0	55 9	56	56
12	120	86	60 0	56 0	59 1	56	56
19	27	27	60 0	..	60 0	56	..
26	125	125	63 0	62 0	62 10	56	56
	350	316	60 4	57 6	59 10		
Feb.							
2	85	40	65 0	..	65 0	56	..
9	249	..	..	..	..	..	..
16	259	169	64 6	61 0	61 11	56	56
23	142	72	63 6	..	63 6	56	..
	735	281	64 2	61 0	62 9		

BARLEY—*continued.*

Date.	Quantity offered for Sale.	Quantity Sold.	Highest Price.	Lowest Price.	Average Price.	Table of Bushel-weights for Highest Price.	Table of Bushel-weights for Lowest Price.
1916 March	Imp. qr.	Imp. qr.	s. d.	s. d.	s. d.	lb. lb.	lb. lb.
1	150	130	64 6	..	64 6	56	..
8	358	250	65 0	64 0	64 7	56	56
15	188	168	66 0	63 6	64 8	56	56
22	115	30	65 6	..	65 6	56	..
29	163	23	62 6	..	62 6	56	..
	974	601	64 11	63 9	64 7		
April							
5	128	32	65 0	.	65 0	56	..
12	110	11	65 0	64 0	64 7	56	56
19	98	5	65 0	.	65 0	56	..
26	..	..	..	..	..	..	..
	336	48	65 0	64 0	64 11		
May							
3	..	..	..	..	..	..	..
10	..	..	..	..	..	..	..
17	..	..	..	..	..	..	..
24	..	..	..	..	..	..	..
31	..	..	..	..	..	..	..
	..	..	..	..	..		
June							
7	..	..	..	..	..	..	..
14	..	..	..	..	..	..	..
21	..	.	..	..	..	..	..
28	..	..	..	..	..	..	..
	..	..	..	..	.		
July							
5	..	..	..	..	..	..	..
12	..	..	..	..	..	..	..
19	..	..	..	..	..	..	..
26	..	..	..	..	..	..	..
	..	..	..	..	..		
Aug.							
2	..	..	..	..	.	..	..
9	..	..	..	..	..	..	..
16	..	..	..	..	..	..	..
23	..	..	..	..	..	..	..
30	..	..	..	..	..	..	..
	..	..	..	..	..		
Sept.							
6	35	..	..	..	..	..	..
13	203	180	60 0	57 6	58 10	56	56
20	590	590	61 6	57 0	59 7	56	56
27	1,010	905	61 6	57 0	59 9	56	54
	1,838	1,675	61 1	57 2	59 7		
Oct.							
4	681	351	59 0	50 6	56 9	55	53
11	149	112	60 0	58 0	59 7	56	56
18	125	125	62 0	58 6	60 5	56	56
25	263	208	63 0	59 0	60 5	56	56
	1,218	796	60 4	56 1	58 8		

Barley—*continued.*

Date.	Quantity offered for Sale.	Quantity Sold.	Highest Price.	Lowest Price.	Average Price.	Table of Bushel-weights for Highest Price.		Table of Bushel-weights for Lowest Price.	
1916 Nov.	Imp. qr	Imp. qr.	s. d.	s. d.	s. d.	lb.	lb.	lb.	lb.
1	871	358	68 0	59 0	63 0		56	55	56
8	598	589	71 0	65 0	68 1		56		56
15	618	281	74 6	68 0	71 8		56		55
22	557	357	71 0	50 0	68 1		56		56
29	454	402	72 6	58 0	67 11		56		54
	2,598	1,987	71 5	58 11	67 8				
Dec. 6	394	123	73 0	58 0	69 2		56		54
13	416	256	76 0	63 0	71 10		56		56
20	563	293	76 6	69 0	74 2		56		56
27	330	255	71 6	70 0	70 4		56		56
	1,703	927	73 10	68 4	71 10				
Result for year	9,752	6,631	65 8	62 8	64 8				

OATS.

Date.	Quantity offered for Sale.	Quantity Sold.	Highest Price.	Lowest Price.	Average Price.	Table of Bushel-weights for Highest Price.		Table of Bushel-weights for Lowest Price.	
1916 Jan. 5	724	440	36 0	30 0	32 9		42		42
12	722	671	37 0	32 0	35 1		44½		42
19	907	826	38 6	33 0	35 5		44½		41
26	1,256	482	37 6	32 9	35 6		44½		41
	3,609	2,419	37 3	31 11	34 10				
Feb. 2	1,402	727	34 9	32 0	33 6		43½		42
9	1,453	661	35 0	32 0	33 1		44½		42
16	1,204	781	35 3	31 6	33 4		44		42
23	871	534	35 0	32 0	33 7		44½		42
	5,020	2,703	35 0	31 11	33 4				
March 1	1,077	519	34 6	31 6	33 3		44½		42
8	1,128	580	34 6	32 0	32 9		43		42
15	1,166	647	37 0	30 6	32 9		43		42
22	820	313	33 0	30 0	31 8	43	44½		42
29	749	503	34 0	29 6	31 6	42	43		42
	4,940	2,562	34 5	31 4	32 5				
April 5	628	319	34 0	30 6	32 9	42	44¼		42
12	354	150	34 6	32 0	33 0		44½		42
19	250	160	34 6	33 0	34 0		43		42
26	501	265	38 0	33 0	35 1		44½		42
	1,728	894	35 3	32 2	33 8				
May 3	592	364	37 0	34 0	35 0		44½		42
10	786	382	38 0	34 0	36 7		44½	42	43
17	746	240	38 0	33 6	36 9		44½		42
24	433	43	37 6	34 6	36 3		44¼		42
31	574	361	35 6	32 0	33 7	43	44½		42
	3,131	1,390	37 1	33 9	35 5				

OATS—*continued.*

Date.	Quantity offered for Sale.	Quantity Sold.	Highest Price.	Lowest Price.	Average Price.	Table of Bushel-weights for Highest Price.		Table of Bushel-weights for Lowest Price.	
1916	Imp. qr.	Imp. qr.	s. d.	s. d.	s. d.	lb.	lb.	lb.	lb.
June									
7	575	494	35 6	32 0	33 8		44½		42
14	441	396	34 8	32 0	33 3	44	44½		42
21	374	269	35 0	32 9	33 6		44½		42
28	670	560	34 6	31 6	32 6		43		42
	2,060	1,719	34 7	31 10	33 1				
July									
5	585	385	34 0	32 6	33 3	43	44½		42
12	252	198	36 0	33 0	34 7		43		42
19	595	270	36 0	33 6	34 10		43½		42
26	421	108	36 6	34 6	35 6		44½		42
	1,853	956	35 8	32 11	34 3				
Aug.									
2	527	115	35 3	35 0	35 0		42		42
9	378	248	38 0	34 0	35 10		44½		42
16	835	575	37 6	34 6	35 6		43		42
23	824	325	37 6	34 6	36 0	43	44½		42
30	744	254	37 0	35 0	36 2		44½		42
	3,308	1,517	37 4	34 7	35 9				
Sept.									
6	1,063	342	35 0	33 0	34 6	42	44		42
13	811	380	35 0	32 0	33 6		44		42
20	1,244	905	36 0	31 0	33 1		43½		42
27	848	648	36 0	31 0	33 3	43	44		42
	3,966	2,275	35 5	31 7	33 5				
Oct.									
4	458	295	34 6	32 0	33 8		42		42
11	646	446	37 0	33 6	35 3		44		42
18	193	68	38 0	34 0	35 11		42		42
25	130	85	37 0	36 6	36 8		42		42
	1,427	894	36 0	34 0	34 11				
Nov.									
1	160	160	41 0	40 0	40 8		42		42
8	219	149	42 6	38 0	41 9		42		37½
15	480	480	46 0	37 0	44 4		42		39¼
22	287	287	46 6	42 0	45 4	42	42½		42
29	338	278	50 0	42 0	47 2		44½		41
	1,484	1,354	44 1	39 10	44 5				
Dec									
6	644	584	52 6	45 0	50 8		42		42
13	596	457	54 0	44 0	51 10	42	43		42
20	1,074	576	53 0	48 0	51 2		42		42
27	620	510	53 0	47 6	49 9		42½		42
	2,934	2,127	53 1	46 5	50 10				
Result for year	35,460	20,810	38 1	33 3	36 4				

BEANS—*Nil.*

PRICES OF SHEEP SINCE 1818.

TABLE No. 1.—CHEVIOT SHEEP.

Year.	Wethers.					Ewes.					Lambs.				
	s.	d.		s.	d.	s.	d.		s.	d.	s.	d.		s.	d.
1818	28	0	to	30	0	not quoted.					8	0	to	10	0
1819	25	0	"	27	0	15	0	to	17	0	10	6	"	12	0
1820	20	0	"	25	0	16	0	"	17	0	10	0	"	11	0
1821	18	0	"	20	0	14	0	"	16	0	7	6	"	8	0
1822	12	6	"	18	0	8	0	"	8	6	4	6	"	0	0
1823	13	6	"	18	0	7	0	"	10	6	5	6	"	6	0
1824	14	0	"	19	0	7	0	"	9	0	4	6	"	6	0
1825	29	0	"	32	0	15	0	"	19	0	9	0	"	10	6
1826	17	6	"	21	6	13	0	"	15	0	7	0	"	7	6
1827	15	0	"	24	0	not quoted.					7	0	"	8	0
1828	18	0	"	27	6	12	0	to	15	0	7	0	"	8	3
1829	18	0	"	24	0	12	6	"	14	0	7	0	"	8	6
1830	15	0	"	21	0	8	0	"	11	0	6	0	"	6	9
1831	18	0	"	25	0	9	0	"	18	0	7	0	"	8	0
1832	19	0	"	24	0	11	0	"	16	0	7	0	"	9	0
1833	22	0	"	31	0	18	6	"	20	0	8	0	"	11	3
1834	22	0	"	31	0	18	6	"	21	0	9	0	"	11	6
1835	22	0	"	27	6	18	0	"	20	6	8	0	"	11	0
1836	24	0	"	31	6	16	0	"	19	0	10	0	"	14	0
1837	19	0	"	28	0	14	0	"	19	0	10	0	"	18	0
1838	28	0	"	30	6	17	0	"	22	0	12	0	"	14	0
1839	28	0	"	31	0	14	0	"	19	0	0	0	"	18	0
1840	24	0	"	33	0	15	0	"	28	0	7	0	"	11	6
1841	28	0	"	30	0	14	0	"	22	0	8	0	"	12	0
1842	22	6	"	28	0	13	0	"	17	0	7	6	"	10	0
1843	19	0	"	25	0	8	0	"	12	0	5	0	"	8	0
1844	21	0	"	29	0	10	0	"	16	0	8	0	"	10	6
1845	28	0	"	33	0	18	0	"	20	0	8	0	"	18	0
1846	24	0	"	33	6	14	6	"	21	6	10	0	"	14	6
1847	24	0	"	35	0	18	0	"	24	0	11	6	"	15	0
1848	28	0	"	34	6	18	0	"	28	0	11	6	"	15	0
1849	21	0	"	30	2	12	0	"	21	0	0	0	"	14	0
1850	20	6	"	29	6	12	0	"	20	0	8	0	"	18	0
1851	21	6	"	31	0	18	0	"	21	0	8	9	"	14	0
1852	21	0	"	32	0	15	0	"	23	0	8	0	"	14	0
1853	26	6	"	38	0	17	0	"	28	6	9	0	"	17	0
1854	25	0	"	36	0	17	0	"	26	0	9	0	"	16	6
1855	28	6	"	36	0	16	0	"	25	0	10	0	"	17	0
1856	22	0	"	35	6	15	6	"	24	0	10	0	"	15	0
1857	24	0	"	36	0	14	6	"	26	0	10	6	"	14	6
1858	24	0	"	34	6	14	0	"	24	6	10	6	"	14	0
1859	25	0	"	34	6	16	0	"	25	0	10	3	"	14	9
1860	26	0	"	38	0	17	6	"	27	6	12	6	"	17	6
1861	25	0	"	38	6	16	0	"	28	0	9	6	"	16	6
1862	27	0	"	37	6	17	6	"	28	0	10	0	"	16	0
1863	25	0	"	38	6	19	0	"	28	6	10	6	"	16	0
1864	31	0	"	41	0	21	0	"	31	6	14	0	"	18	0
1865	32	6	"	44	0	22	6	"	38	6	14	6	"	20	0
1866	37	0	"	50	0	29	0	"	42	6	15	0	"	26	0
1867	26	0	"	58	0	18	0	"	25	6	12	0	"	16	0
1868	30	0	"	32	0	15	6	"	21	0	7	6	"	18	0
1869	28	0	"	38	0	15	0	"	22	6	7	6	"	14	0
1870	35	6	"	48	0	18	0	"	28	0	10	0	"	17	0
1871	36	6	"	49	0	22	0	"	38	6	14	0	"	20	0
1872	45	0	"	56	0	32	0	"	42	0	16	0	"	22	0
1873	42	0	"	51	0	25	0	"	42	0	15	6	"	22	0
1874	38	6	"	44	6	21	0	"	36	0	12	0	"	17	0
1875	38	0	"	48	6	21	0	"	34	0	18	6	"	28	6
1876	40	0	"	52	6	28	0	"	30	0	18	6	"	25	0
1877	41	0	"	51	0	25	0	"	37	0	15	0	"	24	0
1878	35	6	"	48	0	28	6	"	35	0	14	0	"	22	0
1879	34	0	"	44	0	21	0	"	34	0	14	0	"	20	0
1880	30	0	"	48	6	20	0	"	30	0	12	6	"	20	0
1881	32	6	"	45	6	29	0	"	34	0	14	0	"	20	0
1882	40	0	"	51	0	30	0	"	40	0	14	0	"	20	6
1883	44	0	"	55	6	34	6	"	46	6	15	6	"	28	0
1884	36	0	"	47	6	29	6	"	41	6	12	6	"	20	0
1885	30	0	"	38	0	24	0	"	31	0	12	0	"	18	0
1886	32	0	"	40	0	21	0	"	29	0	12	6	"	19	6
1887	29	0	"	36	0	18	0	"	26	0	11	0	"	16	6
1888	30	0	"	38	0	19	0	"	27	0	12	0	"	17	6

Table No. 1.—CHEVIOT SHEEP—*Continued.*

Year.	Wethers.					Ewes.					Lambs.				
	s.	*d.*		*s.*	*d.*	*s.*	*d.*		*s.*	*d.*	*s.*	*d.*		*s.*	*d.*
1889	36	0	to	44	0	24	0	to	32	0	14	0	to	22	0
1890	31	0	"	40	0	22	0	"	30	0	12	6	"	20	0
1891	27	0	"	33	0	16	0	"	25	0	9	0	"	16	0
1892	22	0	"	30	6	18	0	"	22	0	5	0	"	11	0
1893	26	0	"	35	6	18	0	"	28	6	8	6	"	15	0
1894	26	0	"	37	0	20	0	"	31	0	10	6	"	18	6
1895	28	0	"	39	0	22	0	"	34	0	11	6	"	19	6
1896	24	6	"	34	0	19	0	"	30	6	9	0	"	16	6
1897	27	0	"	36	0	21	0	"	31	6	11	0	"	17	6
1898	27	0	"	37	0	22	0	"	32	6	12	0	"	18	6
1899	24	0	"	33	0	20	0	"	30	6	10	6	"	16	0
1900	26	0	"	36	0	22	0	"	32	6	12	0	"	17	0
1901	25	0	"	32	6	20	0	"	29	6	11	0	"	16	0
1902	24	0	"	31	6	18	0	"	27	6	9	6	"	14	6
1903	26	0	"	34	0	21	0	"	31	0	11	4	"	18	0
1904	28	6	"	36	6	28	0	"	32	6	18	0	"	20	0
1905	27	6	"	35	0	28	0	"	33	0	14	0	"	21	0
1906	30	0	"	38	0	26	0	"	34	6	15	0	"	28	0
1907	28	0	"	34	0	22	0	"	30	6	18	6	"	19	6
1908	26	0	"	32	6	21	0	"	27	6	11	6	"	17	0
1909	24	0	"	31	0	18	0	"	25	6	9	6	"	16	0
1910	27	0	"	35	0	22	0	"	31	0	12	0	"	20	0
1911	24	0	"	31	6	18	6	"	27	6	10	6	"	18	0
1912	26	0	"	34	6	22	0	"	31	0	18	0	"	21	0
1913	30	0	"	39	0	24	0	"	35	6	16	0	"	24	0
1914	32	6	"	41	0	28	0	"	39	0	18	0	"	27	6
1915	36	0	"	46	0	31	0	"	44	0	20	0	"	30	6
1916	40	6	"	51	0	34	0	"	49	0	22	0	"	34	6

Table No. 2.—BLACKFACE SHEEP.

Year.	Wethers.					Ewes.					Lambs.				
	s.	*d.*		*s.*	*d.*	*s.*	*d.*		*s.*	*d.*	*s.*	*d.*		*s.*	*d*
1819	22	0	to	24	0	12	0	to	15	0	8	0	to	9	0
1820	20	0	"	23	3	15	6	"	17	0	7	0	"	8	6
1821	18	0	"	20	0	12	0	"	13	0	6	0	"	7	0
1822	11	6	"	18	6	5	6	"	6	0	4	6	"	0	0
1823	12	0	"	16	0	5	0	"	6	6	4	0	"	5	3
1824	9	6	"	18	6	6	0	"	7	0	4	0	"	5	0
1825	22	0	"	26	0	11	0	"	18	6	6	0	"	9	0
1826	15	0	"	17	0	8	0	"	9	0	4	6	"	6	0
1827	14	0	"	18	6	7	0	"	10	0	6	0	"	7	6
1828	15	0	"	20	0	8	0	"	11	0	5	0	"	7	0
1829	14	0	"	18	0	9	0	"	10	0	6	0	"	7	0
1830	9	6	"	18	6	4	0	"	6	0	4	6	"	6	0
1831	13	0	"	17	9	5	0	"	7	6	5	0	"	6	6
1832	14	0	"	18	0	7	0	"	11	6	6	0	"	7	8
1833	16	0	"	24	0	7	6	"	12	0	6	6	"	9	0
1834	16	0	"	22	0	10	0	"	18	0	6	0	"	8	6
1835	15	0	"	18	9	10	0	"	13	0	7	0	"	8	0
1836	15	0	"	21	0	9	0	"	12	0	8	6	"	11	0
1837	13	0	"	16	0	8	0	"	12	0	8	0	"	9	6
1838	15	0	"	20	6	10	0	"	18	0	not quoted.				
1839	15	0	"	22	0	10	0	"	12	0	7	0	to	8	3
1840	15	0	"	22	6	11	0	"	12	0	7	0	"	9	3
1841	16	0	"	20	0	9	0	"	11	0	6	0	"	8	0
1842	14	0	"	19	0	7	6	"	8	0	5	6	"	7	0
1843	not quoted.					4	9	"	6	6	not quoted.				
1844	15	0	to	21	0	6	6	"	10	0	5	0	to	8	0
1845	14	0	"	23	0	8	0	"	12	0	6	0	"	8	0
1846	13	0	"	24	0	10	0	"	13	0	8	0	"	9	0
1847	20	6	"	25	0	10	0	"	14	0	8	6	"	9	6
1848	20	0	"	24	0	11	3	"	12	0	8	6	"	10	0
1849	not quoted.					not quoted.					7	0	"	7	6
1850	..					..					7	0	"	0	0
1851	17	6	to	23	0	9	0	to	12	0	6	6	"	8	0
1852	18	6	"	22	0	9	6	"	12	0	4	6	"	7	9
1853	23	0	"	27	0	14	6	"	16	6	8	0	"	11	6
1854	20	0	"	26	0	11	0	"	16	6	8	0	"	10	6
1855	23	6	"	26	6	14	0	"	16	0	10	0	"	11	0
1856	17	0	"	24	0	10	0	"	20	0	7	6	"	16	0
1857	28	0	"	29	0	10	6	"	15	0	9	3	"	11	0
1858	20	0	"	27	6	9	9	"	18	9	8	3	"	10	6
1859	20	0	"	25	0	10	0	"	14	0	8	9	"	11	0
1860	21	0	"	27	3	11	0	"	16	0	10	0	"	13	6
1861	21	0	"	29	0	12	0	"	22	0	6	3	"	14	6
1862	16	9	"	27	0	12	0	"	18	3	6	0	"	13	0

TABLE No. 2.—BLACKFACE SHEEP—*Continued.*

Year.	Wethers.	Ewes.	Lambs.
	s. d. s. d.	s. d. s. d.	s. d. s. d.
1863	20 0 to 30 6	13 0 to 16 0	8 0 to 11 6
1864	25 0 " 30 0	15 0 " 19 0	10 0 " 13 6
1865	15 6 " 32 6	15 0 " 25 0	10 0 " 17 0
1866	31 6 " 40 0	20 0 " 36 0	13 6 " 22 6
1867	20 0 " 30 6	14 0 " 22 0	7 6 " 13 6
1868	20 0 " 26 0	10 6 " 18 6	7 0 " 13 0
1869	22 0 " 28 0	11 0 " 14 0	6 9 " 9 0
1870	27 0 " 32 6	13 0 " 22 0	8 0 " 14 6
1871	23 0 " 37 0	13 0 " 28 0	11 0 " 16 3
1872	31 6 " 45 0	18 0 " 32 0	12 6 " 18 0
1873	28 0 " 39 0	16 6 " 27 0	7 0 " 16 0
1874	25 0 " 35 0	18 0 " 20 0	7 0 " 14 0
1875	26 6 " 37 6	15 0 " 21 3	9 6 " 17 6
1876	30 0 " 40 0	19 0 " 24 0	13 0 " 20 6
1877	35 0 " 38 9	18 0 " 25 0	13 6 " 23 0
1878	30 0 " 36 0	17 0 " 23 0	12 0 " 22 0
1879	25 0 " 35 9	16 0 " 24 0	10 6 " 20 0
1880	25 0 " 38 0	16 6 " 22 6	10 0 " 17 0
1881	30 0 " 39 0	15 0 " 23 0	10 0 " 15 0
1882	38 0 " 46 0	20 0 " 28 0	12 6 " 18 6
1883	36 0 " 50 6	24 6 " 33 0	14 0 " 21 6
1884	29 0 " 48 6	19 6 " 28 0	12 0 " 19 6
1885	24 0 " 34 0	18 0 " 22 6	10 0 " 15 0
1886	25 0 " 34 0	12 0 " 22 0	10 6 " 16 0
1887	22 0 " 30 0	11 0 " 19 0	8 0 " 13 0
1888	22 0 " 32 0	18 0 " 24 0	10 0 " 15 0
1889	26 0 " 40 0	18 0 " 29 0	13 0 " 22 0
1890	24 0 " 37 0	14 0 " 27 0	10 6 " 19 0
1891	21 0 " 37 0	10 0 " 24 0	7 6 " 15 0
1892	16 0 " 28 6	6 0 " 17 0	8 0 " 10 0
1893	21 0 " 37 0	12 0 " 24 0	7 0 " 14 6
1894	20 0 " 37 6	14 6 " 26 6	8 6 " 16 0
1895	28 0 " 41 0	16 0 " 28 6	9 0 " 17 0
1896	19 0 " 35 4	13 0 " 24 0	6 0 " 13 6
1897	21 0 " 36 6	15 0 " 25 6	7 0 " 14 6
1898	22 0 " 37 0	16 0 " 26 6	8 0 " 15 0
1899	20 0 " 33 6	13 0 " 24 0	5 6 " 13 0
1900	28 0 " 36 0	16 0 " 26 6	8 0 " 15 6
1901	20 0 " 35 0	14 0 " 25 6	6 6 " 14 6
1902	18 6 " 34 0	12 0 " 24 0	6 0 " 14 0
1903	21 0 " 36 0	15 0 " 28 0	7 0 " 16 6
1904	23 0 " 38 6	18 0 " 30 0	8 6 " 17 6
1905	21 6 " 37 0	19 0 " 31 0	9 0 " 18 6
1906	28 0 " 38 0	20 0 " 33 0	10 0 " 19 6
1907	21 0 " 38 6	17 0 " 28 0	8 6 " 17 6
1908	19 6 " 30 0	15 0 " 24 6	8 0 " 16 0
1909	17 0 " 28 0	11 6 " 22 0	6 3 " 13 0
1910	21 0 " 32 6	16 0 " 27 6	8 0 " 17 0
1911	19 0 " 29 6	14 0 " 24 0	7 0 " 15 0
1912	21 6 " 32 6	17 0 " 27 6	9 6 " 17 6
1913	24 6 " 36 0	21 0 " 31 0	12 6 " 21 6
1914	27 0 " 38 6	25 0 " 34 6	15 6 " 24 0
1915	31 0 " 42 6	29 0 " 39 6	17 0 " 25 6
1916	33 0 " 46 6	31 0 " 42 0	19 0 " 27 6

Year.	Laid Cheviot.	White Cheviot.	Laid Highland.	White Highland.
	s. d. s. d.	s. d. s. d.	s. d. s. d.	s. d. s. d.
1818	40 0 to 42 2	..	20 0 to 22 6	..
1819	21 0 " 22 0	..	10 0 " 10 3	..
1820	20 0 " 22 0	..	9 0 " 10 0	..
1821	18 0 " 20 0	..	9 0 " 10 0	..
1822	12 6 " 14 6	..	5 0 " 6 6	..
1823	9 0 " 10 6	..	5 0 " 5 9	..
1824	13 6 " 15 0	..	6 0 " 6 3	..
1825	10 6 " 22 0	..	10 0 " 10 6	..
1826	11 0 " 14 0	..	5 0 " 5 6	..
1827	11 0 " 14 0	..	5 6 " 6 9	..
1828	8 0 " 11 0	..	5 6 " 6 0	..
1829	8 6 " 11 0	..	4 3 " 0 0	..
1830	9 6 " 11 0	..	4 6 " 5 0	..
1831	17 0 " 20 0	..	7 6 " 8 6	..
1832	14 0 " 16 0	..	7 0 " 7 6	..
1833	18 0 " 20 7	..	10 0 " 11 0	..
1834	21 0 " 24 6	..	5 6 " 7 0	..
1835	19 0 " 20 6	..	9 6 " 10 8	..
1836	21 0 " 25 0	..	10 0 " 14 0	..
1837	12 0 " 14 0	..	7 0 " 7 3	..

Table No. 3.—PRICE OF WOOL—*Continued.*

Year.	Laid Cheviot.	White Cheviot.	Laid Highland.	White Highland.
	s. d. s. d.	s. d. s. d.	s. d. s. d.	s. d. s. d.
1838	19 0 to 22 6	..	6 0 to 10 0	..
1839	18 0 " 20 0	..	8 0 " 12 0	..
1840	15 0 " 0 0	..	7 0 " 0 0	..
1841	15 0 " 16 9	..	6 0 " 7 5	..
1842	12 6 " 14 0	..	not quoted.	..
1843	9 0 " 11 6	..	5 0 to 6 0	..
1844	15 0 " 18 0	..	not quoted.	..
1845	14 6 " 17 6	..	7 6 to 8 6	..
1846	12 0 " 14 6	..	8 0 " 8 6	..
1847	12 6 " 14 0	..	not quoted.	..
1848	9 6 " 11 0	..	4 9 to 0 0	..
1849	12 0 " 16 6	..	6 0 " 6 8	..
1850	15 0 " 17 6	..	8 0 " 8 6	..
1851	12 0 " 16 0	..	8 0 " 9 8	..
1852	18 0 " 15 0	..	8 0 " 9 0	..
1853	19 0 " 22 0	..	11 0 " 12 6	..
1854	12 0 " 15 0	..	7 6 " 8 6	..
1855	14 6 " 19 0	..	8 6 " 9 0	..
1856	19 0 " 21 6	..	11 0 " 0 0	..
1857	19 0 " 24 0	..	18 0 " 14 8	..
1858	15 0 " 17 0	..	8 9 " 10 0	..
1859	18 6 " 24 0	..	10 9 " 11 6	..
1860	22 0 " 32 0	37 0 to 38 0	10 0 " 11 8	..
1861	19 6 " 27 0	from 30s. upwards	not quoted.	..
1862	18 6 " 26 0	30 0 to 37 0	11 6 to 16 0	..
1863	25 6 " 31 0	38 0 " 42 0	15 8 " 17 6	..
1864	31 0 " 39 0	47 0 " 54 0	17 6 " 20 0	..
1865	23 0 " 30 0	44 0 " 45 0	15 0 " 17 0	..
1866	24 0 " 30 0	30 0 " 38 0	14 0 " 16 0	..
1867	16 0 " 21 6	not quoted.	not quoted.	..
1868	19 0 " 26 0	28 0 to 32 0	8 6 to 9 0	..
1869	18 0 " 26 6	not quoted.	8 6 " 10 0	..
1870	15 0 " 28 6	25 0 to 26 0	9 6 " 0 0	..
1871	20 0 " 26 6	30 0 " 34 6	12 0 " 15 0	..
1872	26 0 " 37 6	40 0 " 48 0	18 0 " 21 0	..
1873	17 0 " 18 0	34 0 " 40 0	9 0 " 12 0	..
1874	18 6 " 26 6	30 0 " 34 0	9 6 " 18 0	..
1875	25 0 " 32 0	34 6 " 36 0	12 6 " 16 0	..
1876	20 0 " 24 0	30 0 " 34 6	9 6 " 12 0	..
1877	20 9 " 26 0	28 0 " 30 0	10 0 " 12 0	..
1878	18 9 " 25 0	27 0 " 32 0	8 6 " 11 6	..
1879	15 0 " 17 0	prices very low.	7 0 " 0 0	..
1880	20 0 " 24 0	30 0 to 32 0	10 6 " 11 6	14 0 to 15 0
1881	17 0 " 21 0	27 0 " 30 0	5 0 " 9 6	12 0 " 18 0
1882	14 0 " 18 0	27 6 " 28 0	7 6 " 9 0	18 0 " 14 0
1883	18 0 " 18 0	26 0 " 28 0	6 6 " 8 6	11 6 " 12 6
1884	18 0 " 18 0	26 0 " 28 0	6 6 " 8 6	11 6 " 12 6
1885	12 0 " 17 0	22 6 " 26 0	6 0 " 8 0	11 6 " 12 0
1886	13 0 " 18 0	23 0 " 27 6	6 6 " 8 6	11 6 " 12 0
1887	14 0 " 22 0	28 0 " 28 0	7 0 " 9 0	11 6 " 18 0
1888	18 0 " 20 0	23 0 " 28 0	7 0 " 9 0	11 0 " 12 6
1889	18 0 " 18 0	24 0 " 28 0	7 0 " 9 0	11 0 " 12 6
1890	18 0 " 18 0	24 0 " 28 0	7 0 " 9 0	11 0 " 12 6
1891	12 6 " 18 0	22 0 " 28 0	7 0 " 9 0	11 0 " 12 6
1892	12 0 " 18 0	20 0 " 28 0	7 0 " 8 6	10 6 " 12 0
1893	12 0 " 17 0	20 0 " 27 0	7 0 " 8 0	10 0 " 12 0
1894	12 0 " 16 0	20 0 " 26 0	7 0 " 8 0	10 0 " 12 0
1895	12 0 " 16 0	20 0 " 25 0	7 0 " 8 0	10 0 " 11 6
1896	11 0 " 15 0	19 0 " 24 0	7 0 " 8 0	10 0 " 11 6
1897	11 0 " 14 0	18 0 " 28 0	7 0 " 8 0	10 6 " 12 0
1898	10 0 " 18 0	16 0 " 20 0	7 0 " 8 0	10 0 " 11 6
1899	10 0 " 18 0	18 0 " 18 6	7 0 " 8 0	8 6 " 9 6
1900	9 9 " 12 0	18 0 " 18 6	6 9 " 7 9	8 0 " 9 6
1901	9 0 " 10 0	11 0 " 16 6	5 9 " 6 6	8 0 " 9 0
1902	9 0 " 10 0	11 6 " 17 0	6 0 " 6 6	8 6 " 9 6
1903	10 0 " 12 0	15 0 " 18 0	7 0 " 8 0	11 6 " 12 6
1904	15 0 " 17 0	20 0 " 21 0	9 0 " 10 0	14 0 " 15 0
1905	17 0 " 20 0	24 0 " 26 0	10 0 " 11 0	15 0 " 16 0
1906	18 0 " 21 0	27 0 " 28 6	11 6 " 18 0	16 6 " 17 6
1907	*	22 0 " 24 0	11 0 " 12 6	16 0 " 17 0
1908	*	16 0 " 18 0	†	8 0 " 8 6
1909	*	24 0 " 26 0	†	12 6 " 14 0
1910	*	25 0 " 30 0	†	18 0 " 14 6
1911	*	25 0 " 30 0	†	18 0 " 14 6
1912	*	24 0 " 29 0	†	14 0 " 15 0
1913	*	25 0 " 30 0	†	17 0 " 18 0
1914	*	24 0 " 29 0	†	15 0 " 15 6
1915 ‡	*	42 0 " 46 0		21 0 " 22 0

* No Cheviots smeared now. † No Highlands smeared now. ‡ These are July prices.

PRICE OF WOOL PER STONE OF 24 LB.—*Continued.*

	Cheviot.				Half-bred.				Black-face.		Cross-bred (Blackface Ewe and Leicester Ram).			
	Hogg.		Ewe and Wether.		Hogg.		Ewe and Wether.		Hogg.	Ewe and Wether.	Hogg.		Ewe and Wether.	
	Washed.	Un-washed.	Washed.	Un-washed.	Washed.	Un-washed.	Washed.	Un-washed.			Washed.	Un-washed	Washed.	Un-washed.
	s. d.	s. d	s. d.	s. d.	s d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1916 [1] . . .	36 6	30 0	33 0	27 6	34 6	28 6	33 0	27 6	23 0	23 0	28 6	25 6	28 6	25 6
1916 [1] Caithness & Sutherland	40 0	32 6	34 0	29 0	35 0	29 0	34 0	28 6						

[1] The prices given were prices fixed by Government, and not free market prices.

PREMIUMS AWARDED BY THE SOCIETY IN 1916.

I.—VETERINARY DEPARTMENT.

Class Examinations, 1916.

Silver Medals were awarded to the following :—

ROYAL (DICK) VETERINARY COLLEGE.

Chemistry	G. B. Purvis, South Africa.
Biology	A. E. Ferguson, Edinburgh.
Junior Anatomy	G. B. Purvis, South Africa.
Pathology and Bacteriology	J. P. Rice, Aberdeen.
Materia Medica and Therapeutics	W. S. Petrie, Careston.
Hygiene and Dietetics	W. S. Petrie, Careston.
Veterinary Medicine and Surgery (Horse)	J. D. Coutts, Kemnay.
Veterinary Medicine and Surgery (Ox, &c.)	J. D. Coutts, Kemnay.

GLASGOW VETERINARY COLLEGE.

Chemistry	Joseph A. Turner, Glasgow.
Biology	William J. Rice, Glasgow.
Junior Anatomy	William J. Rice, Glasgow.
Senior Anatomy	Brinley Sayer, Newport, Mon.
Physiology	Brinley Sayer, Newport, Mon.
Stable Management	Carl T. Murphy, Glasgow.
Materia Medica	George L. Bradley, Glasgow.
Pathology	Forbes Mackenzie, Glasgow.
Hygiene	George L. Bradley, Glasgow.
Veterinary Surgery	John S. Keane, Glasgow.
Veterinary Medicine	John S. Keane, Glasgow.

19 Large Silver Medals, £13, 1s. 3d.

II.—DISTRICT COMPETITIONS, 1916.

5 Districts—Grants of £12 each (Section I.)	£60	0	0
11 " Grants of £15 each (Section II.)	165	0	0
1 " Special Grants	3	0	0
6 " Medals for Shows (15 Large)	10	6	3
1 " Medals for Cottages, Gardens, &c. (2 Minor)	0	10	2
3 " Medals for Hoeing Competition	0	15	3
15 " Medals for Ploughing, 1915-16	3	16	3
64 Long Service Certificates, £20, 2s. 11d., and Medals, £17, 1s. 6d. (1915-16)	37	4	5
	£280	12	4

ABSTRACT OF PREMIUMS.

District Competitions	£243	7	11
Long Service Awards	37	4	5
Veterinary Colleges	13	1	3
	£293	13	7

STATE OF THE FUNDS

OF

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND

As at 30th NOVEMBER 1916

I.	Invested in War Stock, Heritable Bonds, Debenture and Preference Railway Stocks, Bank Stocks, &c.		£91,852 19 2
II.	Estimated Value of Building, No. 3 George IV. Bridge	£3,100 0 0	
III.	Estimated Value of Furniture, Paintings, Books, &c.	1,000 0 0	4,100 0 0
IV.	Arrears of Subscriptions considered recoverable		254 12 6
V.	Balances as at 30th November 1916 on Account Current with Royal Bank of Scotland		608 12 8
	Amount of General Funds		£96,816 4 4
VI.	Special Funds—		
	Tweeddale Medal Fund— Heritable Bond, at 4½ per cent		£500 0 0
	Fife and Kinross Perpetual Gold Challenge Cup Fund— £460 Great Central Railway Co. 3½ per cent Second Debenture Stock		400 0 0
	Paisley Gold Cup Fund— £802, 8s. 8d. North British Railway Co. 3 per cent Debenture Stock		600 0 0
	Renfrewshire Gold Cup Fund— £668, 14s. 4d. North British Railway Co. 3 per cent Debenture Stock		500 0 0
	William Taylor Memorial Prize Fund— £401, 2s. 7d. North British Railway Co. 3 per cent Debenture Stock	£300 0 0	
	Sum on Deposit Receipt with British Linen Bank, being Income for 1915 and 1916 not expended	25 15 0	325 15 0
	Amount of Special Funds		£2325 15 0

ALEXAND R CROSS, *Hon. Secretary.*
CHARLES M. DOUGLAS, *Chairman of Directors.*
WM. HOME COOK, C.A., *Auditor.*

Edinburgh, 10*th January* 1917.

ABSTRACT of the ACCOUNTS of the HIGHLAND and

CHARGE.

1 Balances due by Royal Bank of Scotland on Account Current at 30th November 1915			£817 19 5
2. Arrears of Subscriptions outstanding at 30th November 1915		£210 14 6	
Whereof due by Members who have compounded for life, and whose arrears are thereby extinguished . . .	£5 10 0		
Sums ordered to be written off .	76 18 0		
		82 8 0	
			128 6 6
3. Interests and Dividends—			
(1) Interests—			
On Heritable Bonds, less Income-tax .		£648 0 0	
On Railway Debenture and Preference Stocks, do.		1,403 15 4	
On Colonial Government Stocks, do. .		328 3 2	
On Annuity Stocks, do. . . .		56 14 10	
On Edinburgh Corporation Loans, do. .		34 15 9	
		£2,471 9 1	
(2) Dividends—			
On War Stock, less Income-tax	£237 2 5		
On Bank Stocks, do. .	930 19 8		
		1,168 2 1	
			3,639 11 2
4. Subscriptions—			
Annual Subscriptions		£1,446 18 6	
Life Subscriptions		228 18 0	
			1,675 16 6
5. Transactions			16 10 6
6. Income-tax Repaid for year to 5th April 1916 . .			568 12 10
7. Donation towards Motor Trial Expenses			20 0 0
8. Investments Realised			1,700 0 0
9. Receipts in connection with Edinburgh Show, 1916 (postponed) .			82 19 0
Sum of Charge . .			£8,649 15 11

Edinburgh, 10*th January* 1917.

AGRICULTURAL SOCIETY of SCOTLAND for the Year 1915-1916.

DISCHARGE.

1. Establishment Expenses—			
Salaries and Wages—Secretary, £600; Chief Clerk, £350; Second Clerk, £100; Extra Clerk, £78; Typist, £65; Messenger, £69; Retiring Allowance to Messenger, £52			£1,314 0 0
Feu-duty, £28; Taxes, £68, 8s. 6d.			96 8 6
Coals, Gas, Electric Light, &c.			38 3 4
Repairs and Furnishings, £41, 6s. 5d.; Telephone and Telegrams, £17, 1s. 11d.; Insurance, £34, 16s.; Pension Annuity Premiums, £85, 16s.; Turnstiles, &c., purchased, £25, 10s.			204 10 4
			£1,653 2 2
2. Fee to Auditor of Accounts for 1914-1915			75 0 0
3. Education—			
National Diploma in Agriculture		£112 14 9	
National Diploma in Dairying (1916	£90 9 11		
(1915)	20 2 8		
		110 12 7	
			223 7 4
4. Chemical Department—			
Fee to Chemist		£50 0 0	
Analyses to Members and Expenses		99 14 11	
Printing		3 5 6	
			153 0 5
5. Veterinary Department—			
Silver Medals awarded to Students			13 1 3
6. Botanical and Entomological Department—			
Fee to Botanist for year		£25 0 0	
Testing Seeds for Members		4 16 0	
			29 16 0
7. Society's Transactions			897 10 10
8. Ordinary Printing, £69, 8s. 4d.; Advertising, £45, 2s. 7d.; Stationery, Books, &c., £47, 7s. 3d.; Postages, £60; Bank Charges, &c., £5, 6s. 10d.			227 5 0
9. Salary to Consulting Engineer			75 0 0
10. Grants to Public Societies			25 0 0
11. Miscellaneous			185 15 9
12. Investments made			3,200 0 0
13. Special Grant—			
Royal (Dick) Veterinary College			600 0 0
14. Payment in connection with Hawick Show			7 0 0
15. Payments in connection with Edinburgh Show, 1916 (postponed)			89 1 6
16. Premiums and Medals for Local Shows and District Competitions			255 0 1
17. Certificates and Medals for long service			48 7 11
18. Arrears of Subscriptions struck off as irrecoverable			79 2 6
19. Arrears outstanding at 30th November 1916			254 12 6
20. Balance at 30th November 1916 with Royal Bank of Scotland, Edinburgh, on Current Account			608 12 8
Sum of Discharge			£8,649 15 11

ALEXANDER CROSS, *Hon. Secretary.*
CHARLES M. DOUGLAS, *Chairman of Directors.*
WM. HOME COOK, C.A., *Auditor.*

ABSTRACT of the ACCOUNTS of the

CHARGE.

I. **Funds** as at 30th November 1915—			
Amount on Heritable Bond at 4 per cent . . .			£3,500 0 0
£3,193, 6s. 8d. North British Railway Company 3 per cent Debenture Stock, purchased at			2,650 0 0
£550 Lancashire and Yorkshire Railway Company 3 per cent Debenture Stock, purchased at			611 10 6
£500 Queensland 3½ per cent Inscribed Stock, 1950-70, purchased at			450 1 0
£190 London and North-Western Railway Company 4 per cent Guaranteed Stock, purchased at . . .			259 1 11
Temporary Loan with Corporation of Edinburgh . .			180 0 0
			£7,650 13 5
Balance on Account Current with Royal Bank of Scotland .			174 9 2
			£7,825 2 7
II. **Interest on Investments**—			
On £3,500 on Heritable Bond at 4½ per cent, for year to Martinmas 1916 . . .		£157 10 0	
Less tax . .		31 10 0	
		£126 0 0	
On £3,193, 6s. 8d. North British Railway Company 3 per cent Debenture Stock, for year .	£95 16 0		
Less tax . .	20 3 10		
		75 12 2	
On £550 Lancashire and Yorkshire Railway Company 3 per cent Debenture Stock, for year .	£16 10 0		
Less tax . .	2 19 10		
		£13 10 2	
On £500 Queensland 3½ per cent Inscribed Stock, 1950-70, for year	£17 10 0		
Less tax . .	3 14 4		
		13 15 8	
On £190 London and North-Western Railway Company 4 per cent Guaranteed Stock, for year	£7 12 0		
Less tax . .	1 7 8		
		6 4 4	
On £180 lent to Edinburgh Corporation, for year to 11th November 1916 . . .	£6 18 3		
Less tax . .	1 14 6		
		5 3 9	
			240 6 1
III. **Income Tax** repaid for year to 5th April 1916 . . .			38 11 8
Sum of Charge . . .			£8,104 0 4

Edinburgh, 10*th January* 1917.

ARGYLL NAVAL FUND for Year 1915-1916.

DISCHARGE.

I. ALLOWANCES to the seven following Recipients—

M. H. Hopkins (fifth year)			£40	0	0
E. M. C. Parker (third year)			40	0	0
J. K. D. Hutchison (second year)			40	0	0
T. J. S. Bell (first year)			40	0	0
R. E. S. Hugonin (first year)			40	0	0
E. C. C. Greenlees (first year)			40	0	0
J. G. Maclean (first half-year)			20	0	0
			£260	0	0

II. FUNDS as at 30th November 1916—

Amount on Heritable Bond at 4½ per cent	£3,500	0	0			
£3,193, 6s. 8d. North British Railway Company 3 per cent Debenture Stock, purchased at	2,650	0	0			
£550 Lancashire and Yorkshire Railway Company 3 per cent Debenture Stock, purchased at	611	10	6			
£500 Queensland 3½ per cent Inscribed Stock, 1950-70, purchased at	450	1	0			
£190 London and North-Western Railway Company 4 per cent Guaranteed Stock, purchased at	259	1	11			
Temporary loan with the Corporation of Edinburgh	180	0	0			
	£7,650	13	5			
Balance on Account Current with Royal Bank of Scotland	193	6	11			
				7,844	0	4

SUM OF DISCHARGE	£8,104	0	4

ALEXANDER CROSS, *Hon. Secretary.*
CHARLES M. DOUGLAS, *Chairman of Directors.*
WM. HOME COOK, C.A., *Auditor.*

STATE OF RECEIPTS AND PAYMENTS in connection with the Edinburgh Show, 1916 (postponed).

RECEIPTS.

1. Interest from Special Cup, &c., Funds—			
Fife and Kinross Gold Cup			£13 3 8
Renfrewshire Gold Cup			15 16 7
Paisley Gold Cup			19 0 1
Tweeddale Gold Medal			18 0 0
"William Taylor Memorial"			9 9 11
2. Balance of Income of "William Taylor Memorial Fund," per Arch. M'Neilage			5 17 3
3. North British and Mercantile Insurance Co., Refund of Staff Premiums			1 11 6
Sum of Receipts			£82 19 0

PAYMENTS.

1. Replica Cups—			
Fife and Kinross Cup		£13 3 8	
Renfrewshire Cup		15 16 7	
Paisley Cup		19 0 1	
			£48 0 4
2. Insurance and Storage—			
1. M'Andrew & Co., insurance of show plant to 1917		£4 10 0	
M'Andrew & Co., storage of plant to May 1916		10 15 0	
M'Andrew & Co., aircraft insurance of plant		2 5 0	
		£17 10 0	
2. North British and Mercantile Insurance Co., insurance of—			
Gold Cups—Burglary	£4 5 0		
Do. —Fire	2 2 6		
Show staff policy	1 11 6		
		7 19 0	
			25 9 0
3. Income from "W. Taylor Memorial," transferred to Fund Account			15 7 2
4. Cheque Book			0 5 0
Sum of Payments			£89 1 6

ABSTRACT.

Amount of Receipts transferred to Ordinary Account	£82 19 0
Amount of Payments do. do.	89 1 6
Balance of Payments	£6 2 6

ALEXANDER CROSS, *Hon. Secretary.*
CHARLES M. DOUGLAS, *Chairman of Directors.*
WM. HOME COOK, C.A., *Auditor.*

Edinburgh, 10*th January* 1917.

VIEW OF RECEIPTS AND PAYMENTS
For the Year 1915-1916.

RECEIPTS.

1. ANNUAL SUBSCRIPTIONS AND ARREARS received			£1,241 10 0
2. LIFE SUBSCRIPTIONS			228 18 0
			£1,470 8 0
3. INTERESTS AND DIVIDENDS—			
Interests	£2,471 9 1		
Dividends	1,168 2 1		
			3,639 11 2
4. TRANSACTIONS			16 10 6
5. INCOME-TAX repaid for year to 5th April 1916			568 12 10
6. DONATION towards Motor Trial Expenses from Mills & Sons			20 0 0
7. RECEIPTS in connection with Edinburgh Show, 1916 (postponed)			82 19 0
SUM OF RECEIPTS			£5,798 1 6

PAYMENTS.

1. ESTABLISHMENT EXPENSES—		
Salaries and Wages	£1,314 0 0	
Feu-duty, Taxes, Coals, Gas, Repairs, and Furnishings, &c.	339 2 2	
	£1,653 2 2	
2. FEE TO AUDITOR of Accounts for 1914-1915	75 0 0	
3. EDUCATION	223 7 4	
4. CHEMICAL DEPARTMENT	153 0 5	
5. VETERINARY DEPARTMENT	13 1 3	
6. BOTANICAL AND ENTOMOLOGICAL DEPARTMENT	29 16 0	
7. SOCIETY'S TRANSACTIONS	897 10 10	
8. ORDINARY Printing, Advertising, Stationery, Books, &c., Postages, Bank Charges, &c.	227 5 0	
9. SALARY to Consulting Engineer	75 0 0	
10. GRANTS to Public Societies	25 0 0	
11. MISCELLANEOUS	135 15 9	
12. SPECIAL GRANTS	600 0 0	
13. PAYMENT in connection with Hawick Show	7 0 0	
14. PAYMENTS in connection with Edinburgh Show, 1916 (postponed)	89 1 6	
15. PREMIUMS AND MEDALS for Local Shows and District Competitions	255 0 1	
16. CERTIFICATES AND MEDALS for Long Service	48 7 11	
Sum of Payments		4,507 8 3
BALANCE OF RECEIPTS		£1,290 13 3

ALEXANDER CROSS, *Hon. Secretary.*
CHARLES M. DOUGLAS, *Chairman of Directors.*
WM. HOME COOK, C.A., *Auditor.*

EDINBURGH, 10*th January* 1917.

PROCEEDINGS AT BOARD MEETINGS.

MEETING OF DIRECTORS, 1st MARCH 1916.

Mr CHARLES DOUGLAS, D.Sc., of Auchlochan, in the Chair.

Present. — *Ordinary Directors* — Mr Walter Biggar; Mr William Carrick; Mr George W. Constable; Mr John M'Hutchen Dobbie; Mr William Elliot; Mr Murray Little; Mr Robert Macmillan; Mr James M'Queen; Mr William Mungall; Mr D. A. Stewart; Mr R. C. Young. *Extraordinary Directors*—Mr James I. Davidson; Mr Charles Douglas, D.Sc.; Mr Thomas Elder; Sir Archd. Buchan Hepburn, Bart.; Mr J. T. M'Laren; Mr William Poole. *Hon. Secretary*—Mr Alexander Cross. *Treasurer*—Mr David Wilson, D.Sc. *Auditor*—Mr Wm. Home Cook, C.A.

Sulphate of Ammonia.

The SECRETARY reported that a letter had that day been received from Mr William Henderson of Lawton, with copy of a long correspondence regarding the conditions attaching to the supply of Sulphate of Ammonia. It would be impossible to read the whole correspondence at that Meeting.

On the suggestion of the Chairman, it was agreed to remit the letter and correspondence to the Science Committee for consideration, and report to the next Meeting of Directors.

Milking Machines and Motor Implements.

A Minute of Meeting of the Implement Trials Committee of 1st March was read and approved.

The Minute reported—(1) that a Schedule of Inquiries regarding Milking Machines had been drawn up and adjusted, and was ready to be issued to past and present users of these machines; (2) that it had been remitted to the following Sub-Committee to prepare a statement of the more important conditions to be fulfilled by motor implements suitable for use in Scotland: Mr J. T. M'Laren, *Convener;* Mr J. M'Hutchen Dobbie, Mr W. T. Malcolm, Mr William Poole, Mr R. C. Young, and Professor Stanfield.

Royal (Dick) Veterinary College.

A Minute of Meeting of Finance Committee of 1st March, with regard to the further application by the Royal (Dick) Veterinary College for a grant towards the Building Fund of the College, was submitted.

The Minute recommended that the Society offer an additional grant of £600 (making a grant of £1000 in all) towards the capital expenditure, on condition that the Society is assured that the College will be continuously maintained as a teaching institution in Veterinary Medicine and Surgery.

Dr DAVID WILSON, Convener, in moving approval, stated that the Directors would see from the copy of the correspondence in their hands that the information the Committee had had before them at their last Meeting was not quite complete. The last letter from Professor Rankine had put the matter in a somewhat different light, and at their Meeting to-day they had had the advantage of the presence of Professor

Rankine and Principal Bradley, who had placed before them what they considered the more urgent part of their position, and had answered questions put by members of the Committee. The Committee had then very carefully considered the whole matter, and their decision was embodied in the recommendation contained in the Minute.

Mr WILLIAM POOLE seconded, and the recommendation was approved.

MEETING OF DIRECTORS, 5TH APRIL 1916.

Mr CHARLES DOUGLAS, D.Sc., of Auchlochan, in the Chair.

Present.—Ordinary Directors—Mr George Bean; Mr William Carrick; Mr George W. Constable; Mr John M'Hutchen Dobbie; Mr James Elder; Mr William Elliot; Colonel G. J. Fergusson-Buchanan; Mr Hugh M. Leadbetter; Mr Peter Macintyre; Mr Robert Macmillan; Mr James M'Queen; Mr Hugh Martin; Mr William Mungall; Mr G. Bertram Shields; Mr R. D. Thom. *Extraordinary Directors*—Mr James Allison; Mr James I. Davidson; Mr Charles Douglas, D.Sc.; Mr Thomas Elder; Mr David Ferrie; Sir Archibald Buchan Hepburn, Bart.; Mr J. Ernest Kerr; Mr J. T. M'Laren. *Honorary Secretary*—Mr Alexander Cross. *Treasurer*—Mr David Wilson, D.Sc. *Chemist*—Mr J. F. Tocher, D.Sc.

Royal (Dick) Veterinary College.

A letter was read from Professor John Rankine, K.C., Chairman of the Board of Management of the Royal (Dick) Veterinary College, dated 1st inst., expressing the thanks of the Board for the proposed grant towards the capital expenditure on the new College buildings, and stating that the conditions attached to the grant would be scrupulously fulfilled.

Edinburgh Agricultural Association.

A letter from the Secretary of the Edinburgh Agricultural Association, dated 31st ult., applying for a grant in aid of the funds of the Association's Show, to be held on 12th July, was remitted to the Finance Committee for consideration and report.

Resignation of Mr John M. Martin.

A letter, dated 1st inst., from Mr John M. Martin, was read, expressing his desire to be relieved of the duties of an Extraordinary Director.

The CHAIRMAN said that the Board would feel that at the termination of a connection with the Society of such long standing, and one so advantageous to the Board for so many years, they would wish in some way to mark their appreciation of Mr Martin's services, by Minute or otherwise. He moved that the letter be remitted to the Office-bearers' Committee to report on the subject to next Meeting of the Board.

This was agreed to.

Nomination of Directors.

The SECRETARY submitted the usual Report of Meetings of Members held in the various Show Divisions for the nomination of Ordinary Directors.

In the case of the Inverness Division, where the gentleman nominated did not see his way to accept office, it was agreed, on the suggestion of the Chairman, to follow the usual practice of the Board and remit to the other three Ordinary Directors for the Division to submit a recommendation to next Meeting.

Sulphate of Ammonia.

A Minute of Meeting of Science Committee, dated 5th April, dealing with the letter and relative correspondence forwarded by Mr William Henderson of Lawton, was submitted and approved.

The Minute recommended the adoption of the following resolution: "The attention of the Board of Directors of the Highland and Agricultural Society of Scotland having been called to the conditions under which Sulphate of Ammonia was distributed during last winter, the Board expresses its regret that the circumstances of

Scottish Agriculture do not appear to have been adequately considered in the arrangements made, and its very earnest hope that these circumstances may be kept in view in any future arrangements that may be made. It further urges that this can only be secured by direct representation of Scottish farming interests on the Fertilisers Committee.

Export of Pure-bred Stock.

A letter from the Secretary of the United Banffshire Agricultural Society, dated 11th March, and resolution passed by that Society regarding the increase in outward freights for pedigree stock, were submitted.

Mr ALEXANDER CROSS of Knockdon said this was a matter more for the various Breed Societies to consider than for this Society to take up. He moved that the Directors take no action in the meantime.

This was agreed to.

Fiars Prices.

Mr GEORGE W. CONSTABLE, Traquair Estates Office, moved the adoption of the following resolution:—

> "That the Directors of the Highland and Agricultural Society urge upon the Government the necessity of passing into law, as soon as possible, the recommendations of the Departmental Committee (1910) on the striking of fiars prices."

Mr CONSTABLE dealt at length with the recommendations of the Committees which reported in 1900 and 1910. The latter Committee reported that the present system of striking fiars prices was eminently unsatisfactory, and that legislation was necessary to effect improvements. He pointed out that not only heritors and parish ministers were affected by this question. A large number of feuars in Scotland and vassals of the Crown paid feu-duties in accordance with the fiars prices, and there were many farmers who paid a portion of their rent according to the same scale. In seven counties in Scotland the practice prevailed of fixing the valuation of crops at Whitsunday entries on the basis of fiars prices.

Mr JAMES INGLIS DAVIDSON, who had been a member of the 1910 Committee, seconded. He referred especially to the recommendation of the Committee that all sales from the end of harvest until the end of March should be taken into account. At present only sales from 1st November to 1st March were taken account of, and the experience of the past season showed that this did not yield an equitable result.

The resolution was adopted, and the Secretary was instructed to forward a copy to the Secretary for Scotland.

Long Service Medals and Certificates.

A Minute of Meeting of the Sub-Committee appointed to consider the design of the Long Service Medal and Certificate, dated 5th April, was submitted and approved.

The Minute recommended the adoption of a medal of a new design, of which a sketch was submitted, and also a sample showing the class of work.

Office-Bearers for 1916-17.

A Minute of Meeting of Committee, dated 5th April, was submitted.

The CHAIRMAN said that the Committee had been placed in this difficulty, that the Show Directors, being Extraordinary Directors, had now already been nominated by the Board twice, and it was therefore not competent for the Board to nominate them again. It was to be regretted that the alteration of the Bye-Laws should have affected them in this particular instance, but the Committee had no alternative. This would explain to the Meeting the recommendations of the Committee.

The SECRETARY said that of the ten Show Directors, one, Mr Harry Hope, M.P., did not come under the Bye-Law, he having been elected only in January of this year.

The Minute was approved.

Science.

A further Minute of Meeting of Science Committee of 5th April was read and approved.

The Minute stated that the Committee had considered an application by Professor Cossar Ewart for a grant towards the expenses of an inquiry into the development of the horse, but did not see their way to recommend that a grant be given.

MEETING OF DIRECTORS, 3RD MAY 1916.

Mr CHARLES DOUGLAS, D.Sc., of Auchlochan, in the Chair.

Present.—Ordinary Directors—Mr William Carrick; Mr George W. Constable; Mr John M'Hutchen Dobbie; Mr James Elder; Mr Hugh M. Leadbetter; Mr Murray Little; Mr William Macdonald; Mr Peter Macintyre; Mr James M'Queen; Mr William Mungall; Mr G. Bertram Shields; Mr D. A. Stewart; Mr Robert C. Young. *Extraordinary Directors*—Mr Charles Douglas, D.Sc.; Mr Thomas Elder; Mr David Ferrie; Mr Robert Macdiarmid; Mr William Poole; Mr John C. Robertson. *Hon. Secretary*—Mr Alexander Cross. *Chemist*—Mr J. F. Tocher, D.Sc. *Treasurer*—Mr David Wilson, D.Sc. *Engineer*—Professor Stanfield.

Edinburgh Agricultural Association.

A Minute of Meeting of the Finance Committee, dated 3rd May, with regard to the application by the Edinburgh Agricultural Association for a special grant towards the expenses of their forthcoming Show was submitted and approved.

The Minute, after referring to the special circumstances under which a grant was given last year, stated that no such special circumstances existed in the present year, and the case of the Edinburgh Agricultural Association was not sufficiently differentiated from that of other local Societies to warrant a special grant from the Society.

Sulphate of Ammonia.

The SECRETARY read letters from (1) the Secretary for Scotland, dated 12th April; and (2) the Board of Agriculture and Fisheries, dated 15th April, in reply to the resolution passed at last Meeting of the Board with regard to the supply of Sulphate of Ammonia. In the former it was stated that the Secretary for Scotland was satisfied that Scotland was very competently represented at the present time on the Fertilisers Committee.

Mr JAMES ELDER, Athelstaneford Mains, expressed dissatisfaction with the reply received from the Secretary for Scotland. He was strongly of opinion that Scottish Agriculture was not adequately represented at the present time on the Fertilisers Committee, and he thought the Directors would be remiss in their duty if they allowed the matter to pass without taking some further action.

The CHAIRMAN suggested that Mr Elder should bring the question up again at next Meeting. The season was now too far advanced for any effective action at present.

Mr ELDER accordingly gave notice that at next Meeting he would submit a resolution to the effect that the Directors insist on the proper representation of practical Agriculture in Scotland on the Fertilisers Committee.

Science.

A Minute of Meeting of Committee, dated 3rd May, was submitted and approved.

The Minute stated that the Committee had considered the suggestion made at the General Meeting in January that the work of the Chemical and Botanical Departments should be handed over to the Agricultural Colleges, and gave the grounds on which they had decided to recommend that no change be made.

Milking Machines Inquiry.

A Minute of Meeting of Sub-Committee, dated 3rd May, was read and approved.

The Minute stated that 102 replies had been received to the Schedule of Inquiries from users of milking machines in Scotland, and gave a table showing the distribution of these machines throughout the various counties. It further recommended that it be remitted to Mr Alexander Cross, Mr J. T. M'Laren, and the Secretary to suggest the name of an expert to consider the replies received, to visit certain of the farms, and to draw up a report dealing with the whole matter.

Vacancy on Board.

Mr D. A. STEWART, Lochdhu, on behalf of the three Ordinary Directors for the Inverness Show Division, moved that the Right Hon. Lord Lovat, Beaufort Castle, Beauly, be nominated for election at the Half-yearly General Meeting in June, as an Ordinary Director representing the Inverness Meeting.

Resignation of Mr John M. Martin.

The following resolution, drawn up by the Office-bearers' Committee in accordance with a remit from last Meeting of the Board, was submitted:—

"That on receiving the resignation of Mr John M. Martin from the Board of the Highland and Agricultural Society, the Directors desire to convey to him an expression of their sense of his long and highly valued services as a member of the Board."

The resolution was unanimously approved for insertion in the Minutes, and the Secretary was instructed to transmit a copy thereof to Mr Martin, and to communicate it to the press for publication.

Finance.

A further portion of the Minute of Committee of 3rd May was submitted and approved.

The Minute recommended a grant of £100 from the St Kilda Fund for the purchase of supplies for the inhabitants of the Island, on similar conditions to the grant given last year.

MEETING OF DIRECTORS, 7TH JUNE 1916.

Mr CHARLES DOUGLAS, D.Sc., of Auchlochan, in the Chair.

Present.—Ordinary Directors—Mr William Carrick; Mr George W. Constable; Mr John M'Hutchen Dobbie; Mr James Elder; Mr Murray Little; Mr William Macdonald; Mr Peter Macintyre; Mr Robert Macmillan; Mr Hugh Martin; Mr William Mungall: Mr G. Bertram Shields; Mr John P. Sleigh; Mr R. D. Thom; Mr Robert C. Young. *Extraordinary Directors*—Mr James Allison; Mr Charles Douglas, D.Sc.; Mr David Ferrie; Sir Archibald Buchan Hepburn, Bart.; Mr Robert Macdiarmid; Mr J. T. M'Laren; Mr William Poole; Mr John C Robertson. *Chemist*—Mr J. F. Tocher, D.Sc. *Engineer*—Professor Stanfield. *Auditor*—Mr Wm. Home Cook, C.A.

The late Lord Kitchener.

The CHAIRMAN referred to the great loss which the Empire had sustained through the tragic death of Lord Kitchener of Khartoum. That was not an occasion, he said, for appraising the place which Lord Kitchener's name would take in history, and his work to his generation. They could not even appreciate yet the immense services he had rendered in these difficult times during the past two years. But it was perhaps the highest testimony to his great services that, while no other man could have rendered them, they had been so rendered that other men could enter into their fuller fruition. Their confidence remained unshaken in the great cause to which they were devoted. He knew that the members of the Board shared to the fullest the pang of sorrow that was felt throughout the whole Empire.

Fertilisers Committee.

Mr JAMES ELDER, Athelstaneford Mains, Drem, again directed attention to the inadequate representation of Scottish Agriculture on the Fertilisers Committee, and moved that a letter in the following terms be sent to the Secretary for Scotland in reply to his letter of 12th April:—

"I am instructed by the Directors of this Society to say that they regret to learn from your letter of 12th April that you disagree with their view that Scottish Agricultural interests should be more adequately represented on the Fertilisers Committee.

"They desire to point out that Mr Dundas White, M.P., who is understood to represent Scotland on the Committee, is not ordinarily resident in Scotland, and has never had any direct connection with Scottish Agriculture. In these circumstances they desire to point out that, whatever other qualifications Mr Dundas White may have to act as a member of the Committee, his presence on it does not afford Scottish Agriculture that direct representation which is enjoyed by English and Irish farmers. In the opinion of the Directors, Scottish Agricultural interests have already suffered

from this fact, and so long as these interests are unrepresented the Fertilisers Committee cannot be expected to secure that confidence on the part of the Scottish farmers which, as they believe you will agree, it is desirable that any such body should possess."

The terms of the letter were approved, an the motion was unanimously agreed to.

Prohibition of Distilling.

Letters were submitted from Sir Robert Usher of Norton, dated 19th May and 5th June, in which he drew the attention of the Directors to a recent regulation under the Defence of the Realm Act which had as its object the prohibition or restriction of distilling by malt or pot still distilleries, and pointing out the serious effect this would have on the price of barley.

On the motion of Mr JAMES ELDER, it was agreed that the letters be allowed to lie on the table.

Milking Machines.

A Minute of Meeting of Sub-Committee, dated 7th June, was submitted and approved.

The Minute recommended that Mr William Burkitt, B.Sc., be appointed as expert to consider the replies received to the Schedule of Inquiries, to visit certain of the farms, and to draw up a report on the whole subject.

Publications.

On the recommendation of the Publications Committee, payments to writers of articles in the 'Transactions,' amounting to £160, 5s., were authorised.

Long Service Medal.

A Minute of Meeting of Long Service Committee, dated 7th June, was read and approved.

The Minute recommended approval of the new design of medal, a sample of which was laid on the table for inspection.

(*At this stage the Board sat in Committee.*)

Argyll Naval Fund.

A Minute of Meeting of Committee, dated 7th June, was read and approved.

The Minute recommended the appointment of Iain Gilleasbuig Maclean to the vacancy in the list of beneficiaries.

Finance.

A Minute of Meeting of Committee, dated 7th June, was submitted and approved.

The Minute stated that the Committee was satisfied that the conditions attached to the proposed further grant of £600 to the building fund of the Royal (Dick) Veterinary College had now been sufficiently met by the assurances contained in a letter, dated 5th June, from the Board of Agriculture for Scotland.

SPECIAL MEETING OF DIRECTORS, 5TH JULY 1916.

Mr CHARLES DOUGLAS, D.Sc., of Auchlochan, in the Chair.

Present.—Ordinary Directors—Mr John M'Hutchen Dobbie; Mr James Elder; Mr William Macdonald; Mr Robert Macmillan; Mr James M'Queen; Mr William Mungall; Mr G. Bertram Shields; Sir Hugh Shaw Stewart, Bart. *Extraordinary Directors*—Mr James I. Davidson; Mr Charles Douglas, D.Sc.; Mr David Ferrie; Sir Archibald Buchan Hepburn, Bart.; Mr J. Ernest Kerr. *Hon. Secretary*—Mr Alexander Cross. *Treasurer*—Mr David Wilson, D.Sc.

Committee on Food Prices.

The CHAIRMAN explained that he had called this Special Meeting of the Board, in accordance with the powers contained in the Standing Orders, to give the Directors an opportunity of considering what action, if any, they should take in view of the appointment of a Departmental Committee to consider the situation arising from the increased cost of food.

The SECRETARY read a letter, dated 28th June, from Mr E. C. Ramsbottom, Secretary of the Committee on Food Prices, giving the terms of the remit to the Committee, which were as follows: "To investigate the principal causes which have led to the increase of prices of commodities of general consumption since the beginning of the war, and to recommend such steps, if any, with a view to ameliorating the situation, as appears practicable and expedient, having regard to the necessity of maintaining adequate supplies."

The CHAIRMAN said it was particularly in view of the last words of the remit, "having regard to the necessity of maintaining adequate supplies," that he thought the Directors might wish to consider the question of offering evidence before the Departmental Committee. Any action should be taken solely with the view of helping the Government to deal with the problem that confronted them, and it was with that view that this Society would approach the question. If the Directors thought that was the best course to take, they might offer to give evidence before the Committee, and this offer might be supplemented by the suggestion that they would be glad to answer any special questions on points affecting Scottish production.

Mr JAMES ELDER, Athelstaneford Mains, Drem, said he thought it was proper that they should offer to give evidence before the Committee. He moved that a witness or witnesses be appointed, and that the Committee be asked to receive their evidence on behalf of the Society.

The motion was unanimously agreed to.

The Chairman and Mr David Ferrie, Parbroath, were appointed to give evidence on behalf of the Society.

On the suggestion of the Chairman, the following gentlemen were appointed a Committee to assist in the preparation of the evidence to be led: Dr David Wilson; Mr Alexander Cross; Mr J. Inglis Davidson; Mr George B. Shields; Sir Archibald Buchan Hepburn, Bart.; Mr Peter M'Intyre; Mr Archibald Whyte; Mr James Elder; Mr Walter Biggar; Mr William Elliot; and Mr John C. Robertson.

The CHAIRMAN asked the Press to make it known that this Committee desired and would welcome suggestions and information, particularly as to facts regarding cost of production, both from Directors and from Members of the Society generally.

This concluded the special business for which the Meeting had been called. It was, however, decided to consider one or two matters which had arisen since the last Meeting of the Board.

Commandeering of Wool.

The SECRETARY read (1) a letter, dated 4th July, from Mr Isaac Connell, S.S.C., on behalf of a Meeting of Scottish Flockmasters held in Edinburgh on 28th June, enclosing copy of resolutions adopted by that Meeting, and asking the Directors to communicate with the Director of Army Contracts in support of these resolutions; and (2) a letter, dated 3rd July, from the Secretary of the Eskdale and Liddesdale Agricultural Society, enclosing copy of a resolution by that Society on the same subject.

After a statement by the Chairman and Mr David Ferrie, it was unanimously decided to appoint a representative on the deputation to be received by Mr H. W. Forster, M.P., Financial Secretary to the War Office, and also to adopt a resolution, copies of which should be forwarded to Mr Forster and the Director of Army Contracts, in favour of the price of the 1915 clip being taken as the basis of adjustment of the price to be paid by Government for commandeered wool.

Mr David Ferrie was unanimously appointed to represent the Society on the proposed deputation, and it was left to him and the Chairman to decide the terms of the resolution, which they subsequently adjusted as follows: "That in the opinion of this Board, the price to be paid by H.M. Government for wool commandeered for army use should be adjusted on the basis of the prices obtaining for the 1915 clip."

MEETING OF DIRECTORS, 1st NOVEMBER 1916.

Mr Charles Douglas, D.Sc., of Auchlochan, in the Chair.

Present.—Ordinary Directors—Mr George Bean; Mr William Carrick; Mr George W. Constable; Mr James Elder; Mr John Elliot; Mr William Elliot; Colonel G. J. Fergusson-Buchanan; Mr Murray Little; Mr William Macdonald; Mr Peter Macintyre; Mr James M'Queen; Mr Hugh Martin; Mr William Mungall; Mr Robert Park; Mr G. Bertram Shields; Mr John P. Sleigh; Mr D. A. Stewart; Mr R. D. Thom; Mr Duncan Wallace. *Extraordinary Directors*—Mr Thomas Blair; Mr Alexander Cowan; Mr Charles Douglas, D.Sc.; Sir Archibald Buchan Hepburn, Bart.; Mr Hugh M. Leadbetter; Mr Robert Macdiarmid; Mr A. D. Macdonald; Mr Robert Macmillan; Mr George D. Mercer, J.P.; Mr C. H. Scott Plummer; Mr William Poole; Mr John C. Robertson; Mr Phipps O. Turnbull. *Treasurer*—Mr David Wilson, D.Sc. *Chemist*—Mr J. F. Tocher, D.Sc. *Hon. Secretary*—Mr Alexander Cross. *Auditor*—Mr William Home Cook, C.A.

The late John M'Hutchen Dobbie.

Before proceeding with the business of the Meeting the Chairman referred in sympathetic terms to the death of Mr John M'Hutchen Dobbie, Campend, who had been a member of the Board for the long period of over twenty years, and had acted as Steward of Gates since the institution of that office in the year 1900. No man, he said, stood higher in the respect of Scottish agriculturists, and no member of the Board was held in greater esteem and affection by them all than their late colleague. He submitted a resolution expressing the Directors' appreciation of the valuable services rendered by Mr M'Hutchen Dobbie to the Society, the deep regret with which they had received the intimation of his death, and their sincere sympathy with Mrs M'Hutchen Dobbie in her bereavement.

The resolution was unanimously adopted, the members present upstanding, and the Secretary was instructed to send an extract thereof to Mrs M'Hutchen Dobbie.

Chairman of the Board for 1916-17.

Sir Archibald Buchan Hepburn of Smeaton, Bart., moved that Mr Charles Douglas, D.Sc., of Auchlochan, be re-elected Chairman of the Board for another year. In doing so he said that during the past three years Dr Douglas had done a great deal of hard work on behalf of the Society, while having the pleasure of presiding over only one Show. He expressed the hope that it might be possible, even in the coming year, to hold a Show, but if not he was sure the Directors would see that Dr Douglas did not retire from the Chair until he had had the honour of presiding over another of their great annual Shows.

Mr Alexander Cross of Knockdon seconded, and the motion was unanimously agreed to.

Dr Douglas, in accepting office, thanked the Directors for the honour they had done him.

Vacancy on Board.

It was remitted to the Ordinary Directors in the Edinburgh Show Division to nominate a Director to fill the vacancy caused by the death of the late Mr M'Hutchen Dobbie.

Standing Committees.

It was intimated that the Standing Committees for the ensuing year had been appointed by the Board in Committee, and the names would be printed as usual in the Premium Book.

Representatives on other Bodies.

The following were appointed representatives of the Society on the Boards of Management of the undernoted institutions for the ensuing year—viz.: *West of Scotland Agricultural College*—Sir Hugh Shaw Stewart, Bart., of Greenock and Blackhall, Ardgowan, Greenock; John M'Caig of Belmont, Stranraer. *Aberdeen and North of Scotland College of Agriculture*—William Duthie, Tarves; Dr J. F. Tocher, 41½ Union Street, Aberdeen. *Glasgow Veterinary College*—Alexander Cross

of Knockdon, 19½ Hope Street, Glasgow. *Scottish Milk Records Association*—Alexander Cross of Knockdon; John M'Caig of Belmont; Sir Hugh Shaw Stewart, Bart., of Greenock and Blackhall.

The appointment of representatives to the Edinburgh and East of Scotland College of Agriculture and the Royal (Dick) Veterinary College was delayed until next Meeting.

Recruiting and Agriculture.

The SECRETARY read a letter from the Secretary of the Board of Agriculture for Scotland intimating that a Conference would be held in the Queen's Hall, Edinburgh, on Friday, 3rd November, for the purpose of discussing the effect of recruiting upon the supply of agricultural labour. The letter suggested that delegates be appointed from the Society, but at the same time pointed out that attendance would not be limited to them, as the Conference was open to all interested.

On the motion of Sir ARCHIBALD BUCHAN HEPBURN, the Chairman of Directors was unanimously appointed as the official representative of the Society at the Conference.

The CHAIRMAN expressed the hope that all Directors would make an effort to be present.

Annual Show.

The CHAIRMAN said the consideration of future arrangements for the Annual Shows of the Society was a question of such great uncertainty that he did not think the Board would wish to take action at that Meeting. Probably it would be most convenient to remit the matter to the Shows Committee for consideration and report, and he moved accordingly.

The motion was unanimously agreed to.

National Diploma in Dairying.

Mr ALEXANDER CROSS, Convener of the Education Committee, submitted Reports on the examination for the National Diploma in Dairying, held at Reading and Kilmarnock in the end of September, showing that 16 candidates presented themselves at Reading, of whom 11 passed, and 15 at Kilmarnock, of whom 10 passed.

Science.

A Minute of Meeting of Science Committee, dated 1st November, was submitted and approved.

The Minute recommended (1) *Bean Meal*—that a representation be made to the Board of Agriculture that maximum and minimum percentages of oil, albuminoids, and carbohydrates should be recognised as characterising the substance known as Bean Meal, and further, that an investigation should be carried out into the properties of different varieties of beans in order that identification tests for all varieties might be elaborated; (2) *Sulphate of Ammonia*—that no action be taken in connection with letters of 27th and 30th July from Mr William Henderson of Lawton; but that the Secretary be instructed to write to the Secretary for Scotland requesting a reply to the representation forwarded by the Directors in June as to the urgent necessity for Scottish Agricultural interests being adequately represented on the Fertilisers Committee.

Publications.

A Minute of Meeting of Committee, dated 1st November, was read and approved.

The Minute stated that it had been remitted to the following Sub-Committee to consider and report as to suggested changes in the tables of information appearing in the 'Transactions' regarding the prices of sheep and wool—viz.: Mr Peter M'Intyre, *Convener;* Mr R. Macmillan; Mr G. B. Shields; and Mr John C. Robertson.

War Pensions, &c., Act.

The SECRETARY read a letter from Sir Thomas Hunter, Town Clerk, regarding the work of the Edinburgh Local Committee and Disablement Sub-Committee, and suggesting that the Directors should appoint a representative to a proposed Conference to be held in Edinburgh shortly on the subject.

On the motion of Dr DAVID WILSON, Sir Archibald Buchan Hepburn of Smeaton, Bart., was appointed to represent the Society at the Conference. In the event of Sir Archibald not being able to attend, he was empowered to ask another Director in the Edinburgh Show Division to take his place.

Motor Implements.

Mr G. B. Shields, Dolphingstone, Convener of the Implements Committee, reminded the Directors that the Society had carried out Trials of Motor Implements, and that the results had been duly published It was impossible to conduct further experiments under existing conditions, but he thought that much good would result if members of the Implements Committee were appointed to visit some of the farms where the motor implements which were on trial last year were working under ordinary farm conditions, and to report to the Directors regarding the work done At the trials these machines were being handled by experts If they had an unbiassed report by members of the Committee it would be of value, as giving information and guidance regarding the work they were capable of performing under ordinary farm conditions.

The Chairman suggested that it be left to the Implements Committee to consider the proposal and report Mr Shields agreed to this being done.

(*At this stage the Board sat in Committee.*)

Finance.

A Minute of Meeting of Committee, dated 1st November, was submitted and approved

The Minute recommended that Mr E M Cowie, Chief Clerk, receive a war bonus at the rate of £25 per annum.

MEETING OF DIRECTORS, 29th NOVEMBER 1916.

Mr Charles Douglas, D Sc, of Auchlochan, in the Chair.

Present —Vice President—Sir Robert Kirk Inches *Ordinary Directors*—Mr George Bean, Mr William Carrick, Mr James Elder, Mr John Elliot, Mr William Elliot, Mr Murray Little, Mr Peter Macintyre, Mr James M'Queen, Mr Hugh Martin, Mr William Mungall, Mr Robert Park, Mr G Bertram Shields, Mr John P Sleigh, Mr D A. Stewart, Brigadier General Archibald Stirling, Mr Duncan M. Wallace *Extraordinary Directors*—Mr Alexander Cowan, Mr Charles Douglas, D Sc, Mr Hugh M. Leadbetter, Mr Robert Macdiarmid, Mr Robert Macmillan; Mr William Poole, Mr John C Robertson, Mr Phipps O Turnbull. *Treasurer*—Mr David Wilson, D.Sc *Hon Secretary*—Mr Alexander Cross. *Chemist*—Mr J. F. Tocher, D.Sc.

Bequest by the late Mr Peter Brock.

A letter was submitted from Messrs D. & J Hill, writers, Glasgow, intimating that the late Mr Peter Brock of Treesbank, Stewarton Drive, Cambuslang, had bequeathed to the Society a sum of £100, free of legacy duty. The legacy would not be payable until the death of a liferenter.

Vacancy on Board.

Mr James Elder, Athelstaneford Mains, on behalf of the Ordinary Directors in the Edinburgh Show Division, nominated Mr Harry Armour, Niddrie Mains, Winchburgh, for election at the General Meeting in January as an Extraordinary Director, to fill the vacancy caused by the death of the late Mr M'Hutchen Dobbie. The nomination was unanimously agreed to.

Representatives on other Bodies.

The following were appointed representatives of the Society on the Boards of Management of the undernoted institutions, these appointments having been postponed from last Meeting—viz *Edinburgh and East of Scotland College of Agriculture*—Sir Archibald Buchan Hepburn of Smeaton, Bart; Mr George G Mercer, J P., Southfield, Dalkeith *Royal (Dick) Veterinary College*—Sir Archibald Buchan Hepburn of Smeaton, Bart.

Meeting of Directors and General Meeting in January.

It was resolved that the next Meeting of the Board be held on Wednesday, 10th January, at 1.30 o'clock, and that the Anniversary General Meeting of the Society be held on the same date, at 3 o'clock.

Mr William Poole moved "that the Anniversary General Meeting of Members of the Society be held in the Side Room of the Corn Exchange, Gorgie."

Mr James Elder seconded.

Mr Peter MacIntyre, Tighnablair, moved as an amendment that the Meeting be held as formerly in the Society's Hall, 3 George IV. Bridge.

Mr James M'Queen, of Crofts, seconded.

On a vote being taken, 22 voted for the amendment and 2 for the motion. The place of meeting accordingly remained unchanged.

Annual Show.

A Minute of Meeting of Shows Committee, dated 29th November, was submitted.

The Minute stated that the Committee had considered the advisability of holding a Show in 1917, and also of recommending, as an alternative to the holding of a general Show, a suggestion that a Show for stock only be held. An invitation had been received from the Town Council of Perth to hold the Show at Perth. The Committee took into consideration the fact that the situation which existed in 1916 with regard to implements and railway facilities would in all probability exist in an intensified form in July 1917. They especially had regard to the urgent recommendation of the Board of Trade that all travelling not absolutely necessary should be avoided. It was further considered that the representations made by farmers as to the shortage of the labour necessary for food production would be seriously prejudiced by diverting to other purposes the considerable amount of labour involved in holding a Show and preparing stock for exhibition. They unanimously agreed to recommend that no Show be held in 1917.

On the motion of Mr Hugh M. Leadbetter, Vice-Convener, the Minute was unanimously approved.

Milking Machines and Motor Implements.

A Minute of Meeting of Implements Committee, dated 29th November, was submitted.

The Minute (1) stated that the Report by Mr William Burkitt, B.Sc., on the Milking Machine Inquiry had been received, and would be circulated for consideration by the Committee at next Meeting; (2) recommended that the following Sub-Committee be appointed to visit farms where motor ploughs and tractors are at work, so as to enable the Society to furnish its members with up-to-date information regarding the capabilities of these implements under ordinary farm conditions,—Mr G. B. Shields, *Convener;* Mr J. T. M'Laren; Mr Phipps O. Turnbull; Mr William Poole; Professor Stanfield; and the Secretary.

On the motion by Mr G. B. Shields, Convener, the Minute was unanimously approved.

Science.

A Minute of Meeting of Science Committee, dated 29th November, was submitted and approved.

The Minute stated (1) *Bean Meal*—that the representation to the Board of Agriculture, proposed at last Meeting, had been withheld in view of certain provisions of the Fertilisers and Feeding Stuffs Act, and it had been remitted to Dr Tocher to draft a letter containing an amended representation on the subject; (2) *Proposed Conference*—that the Committee recommended approval of a suggestion that a Conference be organised by the Society, to be held next year, dealing with the Improvement of Agriculture, and that the matter be remitted back to the Science Committee to consider arrangements, and to report.

Fertilisers Committee.

The Secretary reported that, as instructed at last Meeting, he had written to the Secretary for Scotland requesting a reply to the representation which the Directors had made in June as to the urgent necessity for Scottish Agricultural interests being adequately represented on the Fertilisers Committee. He submitted a reply, dated

9th November, received from Mr Tennant, which was to the effect that the interests of Scotland on the Fertilisers Committee were admirably served by the Member for the Tradeston Division (Mr Dundas White, M.P.), who was in close touch with the Board of Agriculture for Scotland on this matter.

Extreme dissatisfaction was expressed with the terms of this reply, and on the motion of Sir ROBERT K. INCHES, seconded by Mr JAMES ELDER, it was decided to ask the Secretary for Scotland to receive a deputation on the subject on the occasion of his forthcoming visit to Edinburgh. The following gentlemen were appointed to form the deputation: Sir Robert K. Inches (to introduce the deputation), Mr James Elder, Mr G. B. Shields, Mr Phipps O. Turnbull, and Dr David Wilson.

Scottish Council of Agriculture.

A Report by the Provisional Committee, appointed at the Conference of Scottish Agriculturists held in Glasgow on 29th August, which had been printed and circulated to Members of the Board, was submitted.

The CHAIRMAN, after dealing shortly with the constitution and functions of the proposed Scottish Council of Agriculture, moved that the Report be approved, and that the appointment of representatives to the Council be postponed until next Meeting.

Mr JAMES ELDER seconded, and this was unanimously agreed to.

Grants to Local Societies.

A Report by the Shows Committee, dated 29th November, relating to Grants to Local Societies, was submitted.

The Committee recommended eighteen districts for grants of £12 each; fourteen districts for three Silver Medals each; thirteen districts for grants of £15 each for Stallions; special grants of £40 for Highland Home Industries; £20 to Kilmarnock Cheese Show; two Medals each to Ross-shire Crofters' Club, and East of Fife Entire Horse Society; £5 to Shetland Agricultural Society; £3 each to Orkney, Sanday, North Uist, East Mainland, and West Mainland; a Gold Medal and a Silver Medal to the British Dairymaids' Association; seventeen districts for two Medals each; the usual Medals at Ploughing and Hoeing Competitions; and six districts for two Medals each for Cottages and Gardens; Long Service Medals and Certificates, say £50—making the total sum offered in 1917 £602, against £280, 3s. 4d. awarded in 1916.

Mr HUGH M. LEADBETTER, Vice-Convener, in moving approval of the Report, mentioned that eight new applications for grants to Horse Societies had been received, and these had all been granted. It was obvious that this department of improvement in connection with agriculture was being prosecuted with renewed vigour, and, seeing no Show was to be held, the Society was anxious to encourage all such local efforts. The Report was unanimously approved.

Congratulations to Sir Robert K. Inches.

The CHAIRMAN said he was sure the Directors would wish, before they adjourned, to convey to their Vice-President, Sir Robert K. Inches, their warmest congratulations on the conclusion of a distinguished term of office as Lord Provost of the City of Edinburgh. Sir Robert had proved himself, during a very trying period, to be an ideal Lord Provost of the Scottish Metropolis He was a warm friend of the Society, he had been frequently present at their Meetings, and they were indebted to him for the interest he had taken in their work.

Sir Robert K. Inches thanked the Directors for the compliment they had paid him, and expressed the hope that he would be able in the future to devote more of his time to the interests of the Society.

(*At this stage the Board sat in Committee.*)

Finance.

A Minute of Meeting of Committee, dated 29th November, was submitted and approved.

The Minute recommended that the salary of the Secretary, Mr Stirton, be increased by £50 per annum, as from 1st December.

MEETING OF DIRECTORS, 10TH JANUARY 1917.

Mr CHARLES DOUGLAS, D.Sc., of Auchlochan, in the Chair.

Present. — *Ordinary Directors* — Mr Walter Biggar; Mr William Carrick; Mr George W. Constable; Sir Henry Dundas, Bart.; Mr James Elder; Mr John Elliot; Mr William Elliot; Colonel G. J. Fergusson-Buchanan; Mr Murray Little; Mr Peter Macintyre; Mr Robert Park; Mr G. Bertram Shields; Brig.-General Archibald Stirling; Mr R. D. Thom. *Extraordinary Directors*—Mr Thomas Blair; Mr Alexander Cowan; Mr Charles Douglas, D.Sc.; Mr John C. Dudgeon; Sir Archibald Buchan Hepburn, Bart.; Mr Harry Hope, M.P.; Mr Hugh M. Leadbetter; Mr A. D. Macdonald; Mr Robert Macmillan; Mr George G. Mercer; Mr C H. Scott Plummer; Mr William Poole; Mr Phipps O. Turnbull. *Honorary Secretary*—Mr Alexander Cross. *Auditor* — Mr William Home Cook, C.A. *Chemist*—Mr J. F. Tocher, D.Sc. *Consulting Engineer*—Professor Stanfield.

Milking Machines.

A Minute of Meeting of Implements Committee, dated 10th January, was read and approved.

The Minute stated that Mr William Burkitt, B.Sc., had now completed his Report on the Milking Machine Inquiry. The Report had been considered by the Committee, and, after revision, would be circulated to the Directors for consideration at next Meeting.

Science.

1. BEAN MEAL.

A Minute of Meeting of Science Committee, dated 10th January, was read and approved.

The Minute recommended approval of a Representation and relative Note, which had been prepared by Dr J. F. Tocher, Consulting Chemist to the Society, on the desirability of Bean Meal being defined for the purposes of the Fertilisers and Feeding Stuffs Act, for transmission to the Board of Agriculture for Scotland.

2. PROPOSED CONFERENCE ON THE IMPROVEMENT OF AGRICULTURE.

A Minute of Meeting of Science Committee, dated 10th January, was read.

The Minute recommended that the Conference be held in Edinburgh in the early days of August, and invited suggestions from the Board as to subjects for discussion.

The CHAIRMAN said the Committee regarded the Conference as a matter of the very highest importance in regard to the future development of Agriculture in Scotland. It was the duty of the Society to call this Conference together. No other body was in the same position as they were to invite men of the highest eminence in the various departments of Agriculture, not only in Scotland but in other parts of the Kingdom, to address the gathering. He invited discussion as to the most convenient date, and asked for suggestions of subjects of wide interest and general importance, affecting the development of Agriculture in the future, which might find a place on the agenda of such a Conference. The idea was that the Conference might probably last two days, with two sessions on each day.

After discussion, the suggestion contained in the Minute, that the Conference be held in the early days of August, was approved, and the Directors agreed to send in suggestions of suitable subjects for discussion.

Scottish Council of Agriculture.

On the motion of Sir ARCHIBALD BUCHAN HEPBURN, Bart., seconded by Mr ALEXANDER CROSS, the following were appointed representatives of the Society on the Scottish Council of Agriculture for the ensuing year: the Chairman, Dr David Wilson, Mr G. B. Shields, and the Secretary.

Education. Forestry Examinations.

On the recommendation of the Education Committee, it was agreed that the Society's examination for First and Second Class Certificates in Forestry, which is held in alternate years, be held this year as usual—provided any candidates present themselves—on 27th, 28th, and 29th March. The names of Examiners were also submitted.

Clipping of Blackface Sheep.

Mr ALEXANDER COWAN, Valleyfield, Penicuik, submitted the following motion:—

"That it be remitted to a Sub-Committee to consider and report whether the policy of offering prizes for Blackface Sheep, without any restriction as to when they may be clipped, is or is not in the best interests of the breed."

Sir ARCHIBALD BUCHAN HEPBURN, Bart., seconded, and the motion was unanimously agreed to.

The following Sub-Committee was thereafter appointed: the Chairman; Sir Archibald Buchan Hepburn, Bart.; Mr R. Macmillan; Sir Hugh Shaw Stewart, Bart., C.B.; Mr Robert Macdiarmid; Colonel Fergusson-Buchanan; Mr John C. Robertson; Mr John Elliot; Mr William Elliot; Mr Peter Macintyre; Mr M. G. Hamilton; Mr James Clark; Mr Donald M'Dougall; and Mr Alexander Cowan, *Convener.*

Linseed and Cotton-seed.

The CHAIRMAN said he had been approached by the seed-crushers of Scotland to take such steps as might be open to him with regard to the serious position in which the country was being placed through the scarcity of linseed and cotton-seed. The figures provided from official sources were certainly startling. In the year 1914 the volume of imports of oil-producing seeds was 115,000 tons; in 1915, 117,000 tons; and in 1916, only 78,000 tons. These figures alone sufficiently explained the reason of some of the present difficulties. When they came to look at the rates for freight these fears were confirmed. The freight for Bombay cotton-seed per 13 cwt. at 30th June 1916 was 85s., on 12th December 1916 it was 200s. The freight for Egyptian cotton-seed per 20 cwt. at 30th June 1916 was 55s., and at 12th December 1916 it was 235s. These facts were brought before him as Chairman, and while it seemed to him to be a matter for a special meeting, he did not think it would be right, situated as they were, to delay action until that meeting. He therefore took upon himself to bring the matter before Captain Bathurst, M.P., and received from him an acknowledgment and intimation that the gravity of the situation was fully realised, and that it was receiving the immediate attention of Lord Devonport.

After dealing further with the position regarding Egyptian cotton-seed, the Chairman stated that he had written another letter to Captain Bathurst. He did not see that anything further could be done in the meantime.

The Board cordially approved of the action of the Chairman in taking steps to call the attention of the authorities to this important matter.

Slaughter of Cows in Calf, &c.

The CHAIRMAN directed the attention of the Board to a proposal by the Committee on Prices to the effect that the slaughter of all in-calf cows, in-pig sows, and ewes in lamb, should be prohibited. The regulation at present only affected cows in calf, and it was to the effect that the authorities had power to prevent the slaughter of any cow that was obviously and visibly in calf. The proposal of the Committee on Prices went far beyond that. If carried into effect, it would mean that they must prevent heifers intended for feeding being run with the bull, and it would also cripple their efforts to do away with unprofitable dairy cows.

After various members had given expression to their views of the proposal as it would affect cows, sows, and ewes, it was unanimously agreed to disapprove of the proposal to pass such a regulation, and the Secretary was instructed to communicate this decision to the Board of Agriculture for Scotland.

(At this stage the Board sat in Committee.)

Finance.

A Minute of Meeting of Committee, of 10th January, was submitted and approved.

The Minute recommended the payment of fees and expenses to Mr Burkitt in connection with his investigations and Report on Milking Machines, amounting to £72, 17s. 8d.

MEETING OF DIRECTORS, 7TH FEBRUARY 1917.

Mr CHARLES DOUGLAS, D.Sc., of Auchlochan, in the Chair.

Present.—Ordinary Directors—Mr George W. Constable; Mr Peter Macintyre; Mr James M'Queen; Mr William Mungall; Mr Robert Park; Mr G. Bertram Shields; Mr D. A. Stewart; Sir Hugh Shaw Stewart, Bart., C.B. *Extraordinary Directors*—Mr Harry Armour; Mr Thomas Blair; Mr Alexander Cowan; Mr Charles Douglas, D.Sc.; Sir Archd. Buchan Hepburn, Bart.; Mr Robert Macdiarmid; Mr A. D. Macdonald; Mr Robert Macmillan; Mr George G. Mercer; Mr William Poole; Mr John C. Robertson. *Hon. Secretary*—Mr Alexander Cross. *Treasurer*—Mr David Wilson, D.Sc. *Chemist*—Mr J. F. Tocher, D.Sc. *Consulting Engineer*—Professor Stanfield.

The late Duke of Atholl and the late Earl of Elgin.

The CHAIRMAN said it was with deep regret that members of the Board had heard of the death, since last Meeting, of two eminent Scotsmen, both of whom had taken a keen interest in the affairs of the Society—the Duke of Atholl, K.T., and the Earl of Elgin and Kincardine, K.G. The Duke of Atholl was President of the Society in 1887, and the Earl of Elgin was a Vice-President in that year and again in 1912.

He submitted the terms of suitable resolutions, which were unanimously approved, the members present upstanding, and the Secretary was instructed to transmit copies thereof to the relatives of the deceased noblemen.

Motor Ploughing.

The SECRETARY submitted a letter, dated 18th January, from the General Manager of the Caledonian Railway Company, offering the use of two fields at Slateford Station for a demonstration of motor ploughing, it being understood that the Society was contemplating the holding of such demonstrations. To this letter the Secretary had replied that the Directors did not propose to hold further demonstrations in the meantime, but were engaged in inspecting the work of tractors and ploughs on farms under ordinary farm conditions.

On the motion of the CHAIRMAN, the Secretary's reply was approved by the Board.

Science.

A Minute of Meeting of Science Committee, dated 7th February, was submitted and approved.

The Minute contained the following recommendations:—

Unit Values.—That the Schedule of Unit Values of Manures and Feeding stuffs be issued as usual, the various prices being taken from the circular issued by the Board of Agriculture. In the case of sulphate of ammonia the price given would be that fixed by Government, and in the case of superphosphate that quoted for delivery at Glasgow.

Sheep Maggot-Fly.—That it be remitted to Dr Tocher to collect and examine the various proprietory articles sold for the purpose of preventing the ravages of maggot-fly in sheep, and to consider the degree of efficiency of remedial measures taken to destroy this pest.

Joint-Ill.—That the Board of Agriculture be approached with a suggestion that the scope of the present inquiry into the subject of joint-ill in foals be enlarged so as to include calves and lambs, and that the Committee of Inquiry should include members specially interested in cattle and sheep breeding.

Sugar Beet.—That a reply be sent to a letter from Mr Edmund Kimber, dated 16th January, to the effect that the Directors approve of the fullest possible trial being given to the proposal to grow sugar beet and manufacture sugar therefrom in this country.

Proposed Conference.—That the date of the proposed Conference on the Improvement of Agriculture be fixed for Thursday and Friday, the 9th and 10th of August; and that it be remitted to the Chairman of Directors to bring forward at next Meeting suggestions for a programme of business, including names of speakers and subjects for discussion.

Milking Machines.

The Report by Mr William Burkitt, B.Sc., on the Inquiry into the use of milking machines in Scotland, having been printed and circulated to members of the Board, was submitted for approval. (For Report, see page 229.)

Mr G. B. Shields, Convener of the Implements Committee, in moving its adoption, said it was the feeling of the Committee that the Report was of such importance that it should be published forthwith in pamphlet form, so as to be available at the commencement of the milking season. It would be included later in the annual volume of 'Transactions.'

The Report was unanimously approved, and it was agreed to publish it forthwith.

Wool Clip of 1917.

On the motion of Mr Peter M'Intyre, Tighnablair, seconded by Mr Robert Macdiarmid, Mr John C. Robertson, Fodderty, Dingwall, was appointed to represent the Society on a deputation to be received by Mr H. W. Forster, M.P., with regard to the price to be fixed for the wool clip of 1917.

National Policy in Trade.

A letter was submitted, dated 13th January, from the General Secretary of the British Empire Producers' Organisation with regard to a proposed conference with the Prime Ministers of the Overseas Dominions in order to arrive at a basis for a National Policy in Trade, which would develop the resources of the Empire with a view to making it self-supporting.

On the suggestion of the Chairman, it was agreed that, without committing the Society to any view regarding the subjects that might be discussed at the Conference, the Directors express satisfaction that a Meeting of this kind, for the discussion of Imperial problems, should take place.

Report by Chemist on Deficient Samples.

Dr J. F. Tocher, the Society's Chemist, submitted a Report on samples of manures and feeding-stuffs analysed by him for members since the Meeting of the Board in January. Reference having been made to the form in which the guarantee of solubility of mineral phosphates had been given in a particular case, the matter was remitted to the Science Committee for consideration.

Clipping of Blackface Sheep.

A Minute of Meeting of Special Committee on the Clipping of Blackface Sheep, dated 7th February, was submitted and approved.

The Minute stated that the Committee was of opinion that—although late clipping was generally desirable and would benefit the breed—owing to the difficulty of obtaining unanimity on the subject, and owing to the fear that late clipping would act detrimentally to the interests of the Show, it was not desirable to recommend any alteration in the clipping regulations at the present time, the feeling being generally expressed that the difficulty would probably solve itself in the course of a few years.

Next Board Meeting.

The Secretary pointed out that the date of the next Meeting of the Board, 7th March, coincided with the date of the Glasgow Stallion Show. This, as had been found in the past, would interfere with the attendance of certain members of the Board.

The Chairman said that the nature of the business before them was such that no difficulty would arise although the March Meeting were dispensed with.

It was accordingly agreed that the next Meeting of the Board be held on 4th April.

(At this stage the Board sat in Committee.)

Finance.

A Minute of Meeting of Finance Committee, dated 7th February, was submitted and approved.

The Minute recommended the conversion of the Society's holding of 4½ per cent War Stock and 6 per cent Exchequer Bonds into the new 5 per cent War Loan, and the investment of a further sum in the War Loan, making the Society's total holding in the 5 per cent War Loan approximately £10,000—£7000 by conversion and £3000 new money.

PROCEEDINGS AT GENERAL MEETINGS.

GENERAL MEETING, 7TH JUNE 1916.

Mr JOHN M'HUTCHEN DOBBIE in the Chair.

New Members.

Six candidates were balloted for and admitted Members of the Society.

Election of Office-Bearers.

The following noblemen and gentlemen were elected office-bearers of the Society for the year 1916-17:—

President—The Earl of Rosebery, K.G., K.T., Dalmeny Park, Edinburgh.

Vice-Presidents—The Earl of Haddington, Tyninghame, Prestonkirk; The Marquis of Linlithgow, Hopetoun House, South Queensferry; Colonel Wardlaw Ramsay of Whitehill, Rosewell; Right Honourable Sir Robert K. Inches, Lord Provost of Edinburgh, 2 Strathearn Road, Edinburgh.

Ordinary Directors—1913: Sir Henry Dundas, Polton House, Lasswade; Mr George Bean, West Ballochy, Montrose; Mr Peter MacIntyre, Tighnablair, Comrie; Mr Walter Biggar, Grange Farm, Dalbeattie; Mr William Macdonald, Strowan, Annfield Road, Inverness; Mr W. Steuart Fothringham, of Fothringham and Murthly, Murthly; Sir Hugh Shaw Stewart, Bart., of Greenock and Blackhall, Ardgowan, Greenock; Lord Dunglass, Springhill, Coldstream.

1914.—Mr A. F. Irvine of Drum, Drumoak; Colonel G. J. Fergusson-Buchanan of Auchentorlie, Bowling; Mr James M'Queen of Crofts, Dalbeattie; Mr D. A. Stewart, Lochdhu, Nairn; Mr R. D. Thom of Pitlochie, Gateside; Mr William Elliot, Lanark; Mr George W. Constable, Traquair Estate Office, Innerleithen; Mr G. Bertram Shields, Dolphingstone, Tranent.

1915.—Mr William Carrick, The Baad, Stirling; Mr Murray Little, Summerhill, Annan; Mr P. B. Macintyre, Findon Mains, Conon Bridge; Mr William Mungall of Transy, Dunfermline; Major W. T. R. Houldsworth, Kirkbride, Maybole; Mr Samuel Strang Steel of Philiphaugh, Selkirk; Mr James Elder, Athelstaneford Mains, Drem; Mr John P. Sleigh, St John's Wells, Fyvie.

1916.—Major F. J. Carruthers of Dormont, Lockerbie; Lord Lovat, C.B., D.S.O., &c., Beaufort Castle, Beauly; Mr Hugh Martin, Flowerdale, Kinrossie, Perth; Mr Duncan M. Wallace, Paton Street, Glasgow; Mr John Elliot, Meigle, Galashiels; Mr Robert Park, Brunstane, Portobello; Major Alexander T. Gordon of Newton, Insch; Brig.-General Archibald Stirling of Keir, Dunblane.

Extraordinary Directors—Mr Charles Douglas, D.Sc., of Auchlochan, Lesmahagow; Sir Archibald Buchan Hepburn of Smeaton, Bart., Prestonkirk; Mr Robert Macdiarmid, Corries, Lochawe; the Hon. A. D. Murray, Scones Lethendy, Perth; Mr G. H. Scott Plummer of Sunderland Hall, Selkirk; Mr William Poole, Englewood, Blackhall; Mr John C. Robertson, Fodderty, Dingwall; Mr John M'Hutchen Dobbie, Campend, Dalkeith; Mr Hugh M. Leadbetter, Knowesouth, Jedburgh; Mr Robert Macmillan of Holm of Dalquhairn, Woodlea, Moniaive. *Show District.*—

Mr Thomas Blair, Hoprig Mains, Gladsmuir; Mr Alexander Cowan, Valleyfield, Penicuik; Mr John G. Dudgeon, Easter Dalmeny, Dalmeny; Mr John R. Findlay of Aberlour, 27 Drumsheugh Gardens, Edinburgh; Mr Harry Hope, M.P., Barney-hill, Dunbar; Mr William Inglis, Bonnington Park House, Newhaven Road, Edinburgh; Mr A. D. Macdonald, Holyn Bank, Gifford; Mr A. J. Meldrum of Dechmont, Uphall; Mr George G. Mercer, J.P., Southfield, Dalkeith; Mr Phipps O. Turnbull, Smeaton, Dalkeith.

Treasurer—Mr David Wilson, D.Sc., of Carbeth, Killearn.

Honorary Secretary—Mr Alexander Cross of Knockdon, 19 Hope Street, Glasgow.

Alteration of Bye-Laws.

Mr CHARLES DOUGLAS, D.Sc., Chairman of Directors, moved that the Meeting confirm, in terms of the Charter, the following Resolution, which was approved by the Anniversary General Meeting of Members on 12th January 1916: "That the following words be added after the words 'Veterinary Surgeons,' in line 6, Bye-Law No. 2: 'and such other persons as, in respect of their official or other connection with Agriculture, the Board of Directors may consider eligible.'"

Mr R. C. YOUNG seconded, and the Resolution was duly confirmed.

Royal (Dick) Veterinary College.

Mr DAVID FERRIE, Parbroath, submitted the following Resolution, which had been approved, in terms of the Charter, at two previous Meetings of the Board of Directors: "That the Society give an additional grant of £600 (making a grant of £1000 in all) towards the capital expenditure on the Royal (Dick) Veterinary College buildings." In intimating to the College the proposal to recommend this additional grant, the Directors attached a condition that the Society be assured by the Board of Agriculture for Scotland that the College will be continuously maintained as a teaching institution in Veterinary Medicine and Surgery. A satisfactory assurance to this effect had now been received. He accordingly moved adoption of the Resolution.

Mr WILLIAM POOLE seconded, and the Resolution was duly adopted.

Milking Machines.

Mr J. T. M'LAREN, Convener of the Implement Trials Committee, reported that an investigation was in progress with regard to the use of milking machines in Scotland, the object of the inquiry being to ascertain in what way the Society may assist in increasing the use of milking machines. As a first step a schedule of inquiries had been prepared and issued to 176 past and present users of these machines. Over 100 replies had been received, and these contained a large amount of valuable information, which will be of great service to the Directors in the prosecution of the investigation.

Motor Implements.

Mr J. T. M'LAREN also reported that the Directors had under consideration the methods the Society should adopt to encourage the introduction of oil and steam power machines best suited for the requirements of Scottish farmers, and it had been remitted to a Committee to prepare a statement of the more important conditions to be fulfilled by motor implements suitable for use in Scotland.

Agricultural Education.

Sir ARCHIBALD BUCHAN HEPBURN of Smeaton, Bart., submitted the report on the examination held at Leeds in March last for the National Diploma in Agriculture. 35 candidates presented themselves for examination. 11 candidates were from Scotland.

As a result of the examination 10 diplomas were awarded.

Of the 35 candidates, 2 appeared for all the subjects. 15 had passed certain subjects in 1915, and were completing the examination this year, and of these 10 obtained the diploma. The remaining 18 candidates presented themselves for a group of three or four subjects, and of these 8 passed in the subjects for which they appeared, and are entitled to appear for the remaining subjects in 1917.

The Fream Memorial Prize, of the value of £7, 2s. 3d., was awarded to a student of the West of Scotland Agricultural College, Glasgow, who obtained the highest marks in the examination.

Chemical Department.

Dr J. F. TOCHER, Consulting Chemist to the Society, submitted a report on the work done in his department.

The substance of Dr Tocher's report appears in another part of this volume.

In answer to Mr Peter M'Intyre, Dr TOCHER explained, in referring to lambs being infected by poison germs in the soil, he did not mean that the lambs would eat the grass, but they were nosing it, and in that way became infected with the germs.

The CHAIRMAN asked in regard to the water supply.

Dr TOCHER said, in his judgment, each case had to be decided on its merits. It was rather difficult to say whether water that was bad for man would also be bad for beast, but he would be disposed to take the safe line and say it was, as it was difficult to determine the margin between safety and damage.

The CHAIRMAN said he had had experience of that, and he had lost £500 unknown to himself through bad water. The late Principal Williams discovered what was the matter. The man who got a lesson like that was bound to conclude that the only safe way was to get as good water for his stock as he had for himself. The Chairman was also of opinion that far too much had been made during recent years of the importance of potash. Its use had been boomed to a quite inordinate extent, and he was persuaded, from his own experience, that farmers who used a large quantity of good dung did not need to apply potash at all. It did more harm than good.

Botanical Department.

In the absence of Professor A. N. M'Alpine, Consulting Botanist to the Society, Mr JAMES ELDER, Athelstaneford Mains, submitted the following report on the work done in this department:—

I have the honour to report that during season 1916, from January to end of May, I have examined 120 samples of grass, clover, and other seeds for purity and germination. All the samples were good, with the exception of the only sample of tall fescue sent for examination, which germinated only 8 per cent.

The following table shows the maximum and the minimum percentage of purity and of germination obtained by the tests:—

	Purity percentage.		Germination percentage.	
	Maximum.	Minimum.	Maximum.	Minimum.
Red clover and cow grass	100	92		95
Alsike clover	99	94	99	92
White clover	99	92	98	95
Wild white clover	95	87	95	92
Perennial ryegrass	100	94	99	89
Italian ryegrass	100	93	98	85
Hard fescues	94	93	87	81
Red fescues	97	94	86	79
Rough-stalked meadow grass	97	9[illegible]	94	92
Crested Dogstail	99	98	94	90
Timothy	99	97	98	90
Cocksfoot	97	95	95	
Meadow fescues	100		96	93

Mr ELDER said, on the whole these percentages were very satisfactory. In one or two cases the minimum was rather below what it ought to be.

Publications.

Mr CHARLES DOUGLAS, Convener of the Publications Committee, reported that the preparation of the annual volume of 'Transactions' had been considerably delayed by a printers' strike, but that the volume was now nearing completion, and would be issued shortly.

The proceedings terminated with a vote of thanks to the Chairman.

ANNIVERSARY GENERAL MEETING, 10TH JANUARY 1917.

The Right Hon. the EARL OF ROSEBERY, K.G., K.T., President of the Society, in the Chair.

New Members.

Ten candidates were balloted for and elected Members of the Society.

Vacancy on Board of Directors.

On the recommendation of the Board of Directors, Mr Harry Armour, Niddrie Mains, Winchburgh, was elected an Extraordinary Director for one year, in room of the late Mr John M'Hutchen Dobbie.

Finance.

Mr ALEXANDER CROSS of Knockdon, in the absence of the Convener of the Finance Committee, submitted the Accounts of the Society for the year to 30th November 1916. The receipts for the year from all sources reached a total of £5798, 1s. 6d. This sum exceeds the outlays by £1290, 13s. 3d., including life subscriptions to the amount of £228, 18s. In the past year the expenditure on educational work amounted to £223, 7s. 4d., and on work in the chemical and botanical departments to £153, 0s. 5d.

He moved the approval of the usual grant of £20 to the Scottish Meteorological Society, and £5 to the Society for the Prevention of Cruelty to Animals, for the year 1917.

Mr G. W. CONSTABLE seconded, and the Accounts were approved.

Argyll Naval Fund.

Mr PETER M'INTYRE submitted the Accounts of the Argyll Naval Fund for the year to 30th November last. These showed that the income for the year amounted to £278, 17s. 9d., while the expenditure was £260 in grants to seven naval cadets.

The Accounts were approved.

Show of 1917.

Major SCOTT PLUMMER, Convener of the Shows Committee, reported that the Directors had decided, on the unanimous recommendation of the Shows Committee, not to proceed with arrangements for the holding of a Show in 1917. The Shows Committee had carefully considered the possibility of holding a General Show, and also, as an alternative proposal, the holding of a Show of Stock only. An invitation from the Town Council of Perth was received, to hold a Show at Perth. The Committee recognised that the situation which existed in 1916 with regard to implements and railway facilities would in all probability exist in an intensified form in July 1917. They especially had regard to the urgent recommendation of the Board of Trade that all travelling not absolutely necessary should be avoided. It was further considered that the representations made by farmers as to the shortage of labour necessary for food production would be seriously prejudiced by diverting to other purposes the considerable amount of labour involved in holding a Show and in preparing stock for exhibition.

District Shows and Competitions.

Mr HUGH LEADBETTER, Vice-Convener of the Shows Committee, submitted the Report on District Shows and Competitions, showing that in 1916 grants of money and medals had been given in 42 districts. The total expenditure under this head amounted to £280, 3s. 4d. For the current year the Directors proposed the following grants: (1) Under section 1, eighteen districts for grants of £12 each for cattle, horses, and sheep, and fourteen districts in intermediate competition with a grant of three silver medals to each; (2) Under section 2, thirteen districts for grants of £15 each for stallions; special grants of £40 to the Highland Home industries; £20 to Kilmarnock Cheese Show; two silver medals each to Ross-shire Crofters' Club, and East of Fife Entire Horse Society; £5 to Shetland; £3 each to Orkney, Sanday, North Uist, East Mainland, and West Mainland; a gold medal and a silver medal to the British Dairymaids' Association; seventeen districts for two medals each; the

usual medals at ploughing and hoeing competition; two medals each to six districts for cottages and gardens; Long Service Medals and Certificates, say, £50—making the total sum offered in 1917, £602.

While many of the grants offered last year were not claimed on account of Local Societies having abandoned their Shows, it was noteworthy that all the £15 grants to Horse Associations were duly awarded. This department of improvement in agriculture was evidently being prosecuted with renewed vigour. Eight new applications for these grants were received this year, and all were granted. As no Show was to be held, the Society was anxious to encourage all such local efforts.

Applications for medals for hoeing competitions were becoming more numerous, and it had accordingly been decided to place these competitions on the same footing as ploughing matches. Prior application for medals will therefore not now be necessary. A medal will be awarded in ordinary course on receipt of an official report of the competition duly signed by a member of this Society.

Proposed Conference on the Improvement of Agriculture.

Mr Charles Douglas, D.Sc., reported the steps which had been taken by the Directors towards the holding of a Conference in the beginning of August, and invited suggestions from members of suitable subjects for discussion. He expressed the hope that the President of the Society might find it convenient to preside.

The Chairman said he would endeavour to preside at least at one of the Meetings. He had no doubt the Conference would serve a very useful purpose.

Science.

Dr J. F. Tocher, Consulting Chemist to the Society, reported on the work of his department during the year 1916.

The substance of Dr Tocher's Report appears in another part of this volume.

Milking Machines.

Mr G. B. Shields, Convener of the Implements Committee, reported that the investigation which the Society had been conducting with regard to the use of milking machines in Scotland was practically completed. Mr William Burkitt, B.Sc., Grange Hill, Bishop Auckland, had been appointed as an expert to go over the answers received to the Schedule of Inquiries issued to users of these machines, to visit various farms and inspect the machines at work, and to prepare a report on the whole subject for consideration of the Directors. His Report had now been received, and it was anticipated that it would be ready for publication after it had received the approval of the Directors at next Meeting.

Motor Implements.

Mr Shields also reported that the Directors continued to take a deep interest in the development of motor ploughs and tractors. A small Sub-Committee had been appointed to visit farms where these implements are at work, in order to obtain first-hand information as to their capabilities under ordinary farm conditions. The findings of this Sub-Committee, when published, should be of value to members of the Society who may contemplate purchasing these machines in the future.

Education.

Mr Alexander Cross of Knockdon reported on the results of the twenty first examination held last autumn for the National Diploma in Dairying. At the examination in England there were 16 candidates, of whom 11 obtained the diploma and 5 failed; at the examination at Kilmarnock there were 15 candidates, 10 getting the diploma and 5 failing. The names of the successful candidates, as well as the names of the winners of the National Diploma in Agriculture at the examination held last May, will be published in the next volume of 'Transactions'

The examinations for these diplomas will again be held during the ensuing year.

The Society's examinations for First and Second Class Certificates in Forestry, which are held in alternate years, will be held in 1917.

The Report was approved.

Publications.

Mr Douglas reported that the annual volume of 'Transactions' was being prepared, and would be published in spring.

The proceedings terminated with a vote of thanks to the Chairman.

APPENDIX

PREMIUMS

OFFERED BY

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND IN 1917

CONTENTS.

GENERAL NOTICE.

THE HIGHLAND SOCIETY was instituted in the year 1784, and incorporated by Royal Charter in 1787. Its operation was at first limited to matters connected with the improvement of the Highlands of Scotland; but the supervision of certain departments, proper to that part of the country, having been subsequently committed to special Boards of Management, several of the earlier objects contemplated by the Society were abandoned, while the progress of agriculture led to the adoption of others of a more general character. The exertions of the Society were thus early extended to the whole of Scotland, and have since been continuously directed to the promotion of the science and practice of agriculture in all its branches.

In accordance with this more enlarged sphere of action, the original title of the Society was altered, under a Royal Charter, in 1834, to THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND.

Among the more important measures which have been effected by the Society are—

1. Agricultural Meetings and General Shows of Stock, Implements, &c., held in the principal towns of Scotland, at which exhibitors from all parts of the United Kingdom are allowed to compete.

2. A system of District Shows instituted for the purpose of improving the breeds of Stock most suitable for different parts of the country, and of aiding and directing the efforts of Local Agricultural Associations.

3. The encouragement of Agricultural Education, under powers conferred by a supplementary Royal Charter, granted in 1856, and authorising the Society to grant Diplomas to Students of Agriculture; and by giving grants in aid of education in Agriculture and allied sciences. In 1900 the Society discontinued its own Examination, and instituted jointly with the Royal Agricultural Society of England an Examination for a National Diploma in Agriculture.

4. The advancement of the Veterinary Art, by conferring Certificates on Students who have passed through a prescribed curriculum, and who are found, by public examination, qualified to practise. Terminated in 1881 in accordance with arrangements with the Royal College of Veterinary Surgeons.

5. The institution of a National Examination in Dairying, jointly with the Royal Agricultural Society of England.

6. The institution of an Examination in Forestry for First and Second Class Certificates.

7. The appointment of a chemist for the purpose of promoting the application of science to agriculture.

8. The establishment of a Botanical Department.

9. The appointment of Entomologist to advise members regarding insect pests.

10. The annual publication of the 'Transactions,' comprehending papers by selected writers, Prize Reports, and reports of experiments, also an abstract of the business at Board and General Meetings, and other communications.

11. The management of a fund left by John, 5th Duke of Argyll (the original President of the Society), to assist young natives of the Highlands who enter His Majesty's Navy.

CONSTITUTION AND MANAGEMENT.

The general business of THE HIGHLAND AND AGRICULTURAL SOCIETY is conducted under the sanction and control of the Royal Charters, referred to above, which authorise the enactment of Bye-Laws.

The Office-Bearers consist of a President, Four Vice-Presidents, Thirty-two Ordinary and Twenty Extraordinary Directors, a Treasurer, an Honorary and an Acting Secretary, an Auditor, and other Officers.

The Supplementary Charter of 1856 provides for the appointment of a Council on Education, consisting of Sixteen Members — Nine nominated by the Charter, and Seven elected by the Society.

PRIVILEGES OF MEMBERS

MEMBERS OF THE SOCIETY ARE ENTITLED—

1. *To receive a free copy of the 'Transactions' annually.*
2. *To apply for District Premiums that may be offered.*
3. *To report Ploughing Matches for Medals that may be offered.*
4. *To Free Admission to the Shows of the Society.*
5. *To exhibit Live Stock and Implements at reduced rates.*[1]
6. *To have Manures and Feeding-Stuffs analysed at reduced fees.*
7. *To have Seeds tested at reduced fees.*
8. *To have Insect Pests and Diseases affecting Farm Crops inquired into.*
9. *To attend and vote at General Meetings of the Society.*
10. *To vote for the Election of Directors, &c., &c.*

ANALYSIS OF MANURES AND FEEDING-STUFFS

The Fees of the Society's Chemist for Analyses made for Members of the Society shall, until further notice, be as follow:—

The estimation of *one* ingredient in a manure or feeding-stuff	5s.
The estimation of *two or more* ingredients in a manure or feeding-stuff . . .	10s.

These charges apply only to analyses made for the sole and private use of Members of the Highland and Agricultural Society who are not engaged in the manufacture or sale of the substances analysed.

The Society's Chemist, if requested, also supplies valuations of manures, according to the Society's scale of units.

SEEDS, CROP DISEASES, INSECT PESTS, &c.

The rates of charges for the examination of plants and seeds, crop diseases, insect pests, &c., will be had on application to the Secretary.

ELECTION OF MEMBERS

Candidates for admission to the Society must be proposed by a Member, and are elected at the half-yearly General Meetings in January and June. It is not necessary that the proposer should attend the Meeting.

CONDITIONS OF MEMBERSHIP

Higher Subscription.—The ordinary annual subscription is £1, 3s. 6d., and the ordinary subscription for life-membership is £12, 12s.; or after ten annual payments have been made, £7, 7s.

Lower Subscription.—Proprietors farming the whole of their own lands, whose rental on the Valuation Roll does not exceed £500 per annum, and all Tenant-Farmers, Secretaries or Treasurers of Local Agricultural Associations, Factors resident on Estates, Land Stewards, Foresters, Agricultural Implement Makers, and Veterinary Surgeons, none of them being also owners of land to an extent exceeding £500 per annum, and such other persons as, in respect of their official or other connection with Agriculture, the Board of Directors may consider eligible, are admitted on a subscription of 10s. annually, which may be redeemed by one payment of £7, 7s., and after eight annual payments of 10s. have been made, a Life Subscription may be purchased for £5, 5s., and after twelve such payments, for £3, 3s.[2] Subscriptions are payable on election, and afterwards annually in January.

Members are requested to send to the Secretary the names and addresses of Candidates they have to propose (stating whether the Candidates should be on the £1, 3s. 6d. or 10s. list).

JOHN STIRTON, *Secretary.*

3 GEORGE IV. BRIDGE, EDINBURGH.

[1] Firms are not admitted as Members; but if one partner of a firm becomes a Member, the firm is allowed to exhibit at Members' rates.

[2] Candidates claiming to be on the 10s. list must state under which of the above designations they are entitled to be placed on it.

ESTABLISHMENT FOR 1916-1917.

President.

THE EARL OF ROSEBERY, K.G., K.T., Dalmeny Park, Edinburgh.

Vice-Presidents.

The EARL OF HADDINGTON, Tyninghame, Prestonkirk.
The MARQUIS OF LINLITHGOW, Hopetoun House, South Queensferry.
Colonel WARDLAW RAMSAY of Whitehill, Rosewell.
Sir ROBERT KIRK INCHES, 2 Strathearn Road, Edinburgh.

Ordinary Directors.

Year of Election.	
1913	Sir HENRY DUNDAS, Bart., Polton House, Lasswade.
	GEORGE BEAN, West Ballochy, Montrose.
	PETER M'INTYRE, Tighnablair, Comrie.
	WALTER BIGGAR, Grange Farm, Dalbeattie.
	WILLIAM MACDONALD, Strowan, Annfield Road, Inverness.
	W. STEUART FOTHRINGHAM, of Fothringham and Murthly, Murthly.
	Sir HUGH SHAW STEWART, Bart., C.B., of Greenock and Blackhall, Ardgowan, Greenock.
	LORD DUNGLASS, Springhill, Coldstream.
1914	A. F. IRVINE of Drum, Drumoak.
	Colonel G. J. FERGUSSON-BUCHANAN of Auchentorlie, Bowling.
	JAMES M'QUEEN of Crofts, Dalbeattie.
	D. A. STEWART, Lochdhu, Nairn.
	R. D. THOM of Pitlochie, Gateside.
	WILLIAM ELLIOT, Lanark.
	GEORGE W. CONSTABLE, Traquair Estate Office, Innerleithen.
	G. BERTRAM SHIELDS, Dolphingstone, Tranent.
1915	WILLIAM CARRICK, The Baad, Stirling.
	MURRAY LITTLE, Summerhill, Annan.
	P. B. MACINTYRE, Findon Mains, Conon Bridge.
	WILLIAM MUNGALL of Transy, Dunfermline.
	Major W. T. R. HOULDSWORTH, Kirkbride, Maybole.
	SAMUEL STRANG STEEL of Philiphaugh, Selkirk.
	JAMES ELDER, Athelstaneford Mains, Drem.
	JOHN P. SLEIGH, St John's Wells, Fyvie.
1916	Major F. J. CARRUTHERS of Dormont, Lockerbie.
	Lord LOVAT, C.B., D.S.O., &c., Beaufort Castle, Beauly.
	HUGH MARTIN, Flowerdale, Kinrossie, Perth.
	DUNCAN M. WALLACE, Paton Street, Glasgow.
	JOHN ELLIOT, Meigle, Galashiels.
	ROBERT PARK, Brunstane, Portobello.
	Major ALEXANDER T. GORDON of Newton, Insch.
	Brig.-General ARCHIBALD STIRLING of Keir, M.P., Dunblane.

Extraordinary Directors.

1915	Charles Douglas, D.Sc., of Auchlochan, Lesmahagow. Sir Archibald Buchan Hepburn of Smeaton, Bart., Letham, Haddington. Robert Macdiarmid, Corries, Lochawe. The Hon. A. D. Murray, Scones Lethendy, Perth. C. H. Scott Plummer of Sunderland Hall, Selkirk. William Poole, Englewood, Blackhall. John C. Robertson, Fodderty, Dingwall.
1916	Harry Armour, Niddrie Mains, Winchburgh. Hugh M. Leadbetter, Knowesouth, Jedburgh. Robert Macmillan of Holm of Dalquhairn, Woodlea, Moniaive.

Show District.

1916	Thomas Blair, Hoprig Mains, Gladsmuir. Alexander Cowan, Valleyfield House, Penicuik. J. G. Dudgeon, Easter Dalmeny, Dalmeny. John R. Findlay of Aberlour, 27 Drumsheugh Gardens, Edinburgh. Harry Hope, M.P., Barneyhill, Dunbar. William Inglis, Bonnington Park House, Newhaven Rd., Edinburgh. A. D Macdonald, Yester Estates Office, Gifford. A. J. Meldrum of Dechmont, Uphall. George G. Mercer, J.P., Southfield, Dalkeith. Phipps O. Turnbull, Smeaton, Dalkeith.

Office-Bearers.

David Wilson, D.Sc., of Carbeth, Killearn, *Treasurer.*
Alex. Cross of Knockdon, 19 Hope Street, Glasgow, *Honorary Secretary.*
Rev. A. Wallace Williamson, D.D., 44 Palmerston Place, *Chaplain.*
John Stirton, *Secretary.*
Edward M. Cowie, *Chief Clerk and Cashier.*
A. S. Cavers, *Second Clerk.*
William Home Cook, C.A., 42 Castle Street, *Auditor.*
J. F. Tocher, D.Sc., F.I.C., 41½ Union Street, Aberdeen, *Chemist.*
Professor R. Stanfield, A.R.S.M., M.Inst.C.E , F.R.S.E., 24 Mayfield Gardens, Edinburgh, *Consulting Engineer.*
A. N. M'Alpine, 6 Blythswood Square, Glasgow, *Consulting Botanist.*
R. S. MacDougall, M.A., D.Sc., 9 Dryden Place, *Consulting Entomologist.*
Tods, Murray, & Jamieson, W.S., 66 Queen Street, *Law Agents.*
William Blackwood & Sons, 45 George Street, *Publishers.*
Henry Munro, Ltd., 82 Mitchell Street, Glasgow, *Advertising Agents.*
Hamilton & Inches, Princes Street, *Silversmiths.*
Alexander Kirkwood & Son, 9 St James' Square, *Medallists.*
D. Macandrew & Co., 120 Loch Street, Aberdeen, *Showyard Contractors.*
Andrew Brown, *Messenger.*

Chairman of Board of Directors.

CHARLES DOUGLAS, D.Sc., of Auchlochan, Lesmahagow.

Chairmen of Committees.

1. *Argyll Naval Fund* . .	Major John Gilmour, M.P.
2. *Finance, Chambers, and Law*	David Wilson, D.Sc., of Carbeth.
3. *Publications* . . .	Charles Douglas, D.Sc., of Auchlochan.
4. *Shows*	C. H. Scott Plummer of Sunderland Hall.
5. *Science*	David Wilson, D.Sc., of Carbeth.
6. *General Purposes* . .	Charles Douglas, D.Sc., of Auchlochan.
7. *Education*	Alexander Cross of Knockdon.
8. *Forestry*	Sir Archibald Buchan Hepburn, Bart., Letham, Haddington.

COMMITTEES, 1916-1917.

1. ARGYLL NAVAL FUND.

Major John Gilmour, M.P., yr. of Montrave, Pollok Castle, Newton Mearns, *Convener*.
Sir Archibald Buchan Hepburn of Smeaton, Bart., Letham, Haddington.
Sir J. Patten MacDougall, K.C.B., 39 Heriot Row, Edinburgh.
Sir Kenneth Mackenzie of Gairloch, Bart., 10 Moray Place, Edinburgh.
John Maclachlan of Maclachlan, Castle Lachlan, Strachur.
Alexander Cross of Knockdon, 19 Hope Street, Glasgow.
David Wilson, D.Sc., of Carbeth, Killearn.
Charles Douglas, D.Sc., of Auchlochan, Lesmahagow.

2. FINANCE, CHAMBERS, AND LAW.

David Wilson, D.Sc., of Carbeth, Killearn, *Convener*.
Alexander Cross of Knockdon, 19 Hope Street, Glasgow, *Vice-Convener*.
Alexander Cowan, Valleyfield House, Penicuik.
Jas. I. Davidson, Saughton Mains, Corstorphine.
James Elder, Athelstaneford Mains, Drem.
William Elliot, Lanark.
Sir Archibald Buchan Hepburn of Smeaton, Bart., Letham, Haddington.
Hugh M. Leadbetter, Knowesouth, Jedburgh.
Peter M'Intyre, Tighnablair, Comrie.
Robert MacMillan of Holm of Dalquhairn, Woodlea, Moniaive.
C. H. Scott Plummer of Sunderland Hall, Selkirk.
Charles Douglas, D.Sc., of Auchlochan, Lesmahagow, Chairman, *ex officio*.
William Home Cook, C.A., Auditor, *ex officio*.

3. PUBLICATIONS.

Charles Douglas, D.Sc., of Auchlochan, Lesmahagow, *Convener*.
James Elder, Athelstaneford Mains, Drem.
Sir Archibald Buchan Hepburn of Smeaton, Bart., Letham, Haddington.
Murray Little, Summerhill, Annan.
Peter M'Intyre, Tighnablair, Comrie.
Robert MacMillan, of Holm of Dalquhairn, Woodlea, Moniaive.
G. Bertram Shields, Dolphingstone, Tranent.
Sir Hugh Shaw Stewart, Bart., C.B., of Greenock and Blackhall, Ardgowan, Greenock.
R. D. Thom of Pitlochie, Gateside.
David Wilson, D.Sc., of Carbeth, Killearn.
Alex. Cross of Knockdon, Hon. Secretary, *ex officio*.

4. SHOWS.

C. H. Scott Plummer of Sunderland Hall, *Convener*.
H. M. Leadbetter, Knowesouth, Jedburgh, *Vice-Convener*.
George Bean, West Ballochy, Montrose.
Walter Biggar, Grange Farm, Dalbeattie.
Thomas Blair, Hoprig Mains, Gladsmuir.
William Carrick, The Baad, Stirling.
Major F. J. Carruthers of Dormont, Lockerbie.
George W. Constable, Traquair Estate Office, Innerleithen.
Alexander Cowan, Valleyfield House, Penicuik.
James I. Davidson, Saughton Mains, Corstorphine.
J. G. Dudgeon, Easter Dalmeny, Dalmeny.
Sir Henry Dundas, Bart., Polton House, Lasswade.
Lord Dunglass, Springhill, Coldstream.
John Elliot, Meigle, Galashiels.
William Elliot, Lanark.

Colonel G. J. Fergusson-Buchanan of Auchentorlie, Bowling.
John R. Findlay of Aberlour, 27 Drumsheugh Gardens, Edinburgh.
Major A. T. Gordon of Newton, Insch.
Sir Archibald Buchan Hepburn of Smeaton, Bart., Haddington.
Harry Hope, M.P., Barneyhill, Dunbar.
Sir Robert K. Inches, 2 Strathearn Road.
William Inglis, Bonnington Park House, Newhaven Road, Edinburgh.
Lord Lovat, C.B., D.S.O., &c., Beaufort Castle, Beauly.
Robert Macdiarmid, Corries, Lochawe.
A. D. Macdonald, Yester Estates Office, Gifford.
William Macdonald, Strowan, Annfield Road, Inverness.
Peter M'Intyre, Tighnablair, Comrie.
P. B. Macintyre, Mains of Findon, Conon Bridge.
Robert MacMillan of Holm of Dalquhairn, Woodlea, Moniaive.
James M'Queen of Crofts, Dalbeattie.
Hugh Martin, Flowerdale, Kinrossie, Perth.
A. J. Meldrum of Dechmont, Uphall.
George G. Mercer, J.P., Southfield, Dalkeith.
William Mungall of Transy, Dunfermline.
The Hon. A. D. Murray, Scones Lethendy, Perth.
Robert Park, Brunstane, Portobello.
William Poole, Englewood, Blackhall.
John C. Robertson, Fodderty, Dingwall.
G. Bertram Shields, Dolphingstone, Tranent.
John P. Sleigh, St John's Wells, Fyvie.
Samuel Strang Steel of Philiphaugh, Selkirk.
D. A. Stewart of Lochdhu, Nairn.
Sir Hugh Shaw Stewart of Greenock and Blackhall, Bart., C.B., Ardgowan.
Brig.-General Archibald Stirling of Keir, M.P., Dunblane.
Phipps O. Turnbull, Smeaton, Dalkeith.
Duncan Wallace, Paton Street, Glasgow.
David Wilson, D.Sc., of Carbeth, Killearn, Treasurer, *ex officio.*
Alexander Cross of Knockdon, Hon. Secretary, *ex officio.*
Charles Douglas, D.Sc., of Auchlochan, Lesmahagow, Chairman, *ex officio*
Professor R. Stanfield, 24 Mayfield Gardens, Edinburgh, Engineer, *ex officio.*

5. IMPLEMENTS AND MACHINERY.

G. Bertram Shields, Dolphingstone, Tranent, *Convener.*
Thomas Blair, Hoprig Mains, Gladsmuir.
George A. Constable, Traquair Estate Office, Innerleithen.
James Elder, Athelstaneford Mains, Drem.
John Elliot, Meigle, Galashiels.
Hugh M. Leadbetter, Knowesouth, Jedburgh.
William Macdonald, Strowan, Annfield Road, Inverness.
J. T. M'Laren, The Leuchold, Dalmeny.
Hugh Martin, Flowerdale, Kinrossie, Perth.
William Poole, Englewood, Blackhall.
John Sleigh, Strichen Mains, Strichen.
R. D. Thom of Pitlochie, Gateside.
Phipps O. Turnbull, Smeaton, Dalkeith.
Duncan M. Wallace, Paton Street, Glasgow.
Charles Douglas, D.Sc., of Auchlochan, Leshmahagow, *ex officio.*
David Wilson, D.Sc., of Carbeth, Killearn, *ex officio.*
Alexander Cross of Knockdon, 19 Hope Street, Glasgow, *ex officio.*
Professor Stanfield, 24 Mayfield Gardens, *ex officio.*

6. SCIENCE.

David Wilson, D.Sc., of Carbeth, Killearn, *Convener.*
Charles Douglas, D.Sc., of Auchlochan, Lesmahagow, *Vice Convener.*
Walter Biggar, Grange Farm, Dalbeattie.
James Elder, Athelstaneford Mains, Drem.
W. Steuart Fothringham, of Fothringham and Murthly, Murthly.

Sir ARCHIBALD BUCHAN HEPBURN of Smeaton, Bart., Haddington.
WILLIAM INGLIS, Bonnington Park House, Newhaven Road, Edinburgh.
A. F. IRVINE of Drum, Drumoak.
MURRAY LITTLE, Summerhill, Annan.
A. D. MACDONALD, Yester Estates Office, Gifford.
WILLIAM MACDONALD, Strowan, Annfield Road, Inverness.
JAMES M'QUEEN of Crofts, Dalbeattie.
HUGH MARTIN, Flowerdale, Kinrossie, Perth.
C. H. SCOTT PLUMMER of Sunderland Hall, Selkirk.
JOHN C. ROBERTSON, Fodderty, Dingwall.
G. B. SHIELDS, Dolphingstone, Tranent.
Sir HUGH SHAW STEWART, Bart., C.B., of Greenock and Blackhall, Ardgowan, Greenock.
R. D. THOM of Pitlochie. Gateside.
PHIPPS O. TURNBULL, Smeaton, Dalkeith.
ALEXANDER CROSS of Knockdon, Hon. Secretary, *ex officio.*
J. F. TOCHER, Chemist, *ex officio.*
A. N. M'ALPINE, Botanist, *ex officio.*
R. S. MACDOUGALL, D.Sc., Zoologist, *ex officio.*

7. GENERAL PURPOSES.

CHARLES DOUGLAS, D.Sc., of Auchlochan, Lesmahagow, *Convener.*
GEORGE W. CONSTABLE, Traquair Estate Office, Innerleithen.
Sir HENRY DUNDAS, Bart., Polton House, Lasswade.
JAMES ELDER, Athelstaneford Mains, Drem.
Sir ARCHIBALD BUCHAN HEPBURN of Smeaton, Bart., Haddington.
HUGH M. LEADBETTER, Knowesouth, Jedburgh.
A. D. MACDONALD, Yester Estates Office, Gifford.
ROBERT MACMILLAN of Holm of Dalquhairn, Woodlea, Moniaive.
ROBERT PARK, Brunstane, Portobello.
WILLIAM POOLE, Englewood, Blackhall.
G. BERTRAM SHIELDS, Dolphingstone, Tranent.
Sir HUGH SHAW STEWART, Bart., C.B., of Greenock and Blackhall, Ardgowan.
DAVID WILSON, D.Sc., of Carbeth, Killearn, Treasurer, *ex officio.*
ALEXANDER CROSS of Knockdon, Hon. Secretary, *ex officio.*

8 EDUCATION.

ALEXANDER CROSS of Knockdon, 19 Hope Street, Glasgow, *Convener.*
CHARLES DOUGLAS, D.Sc , of Auchlochan, Lesmahagow.
Sir ARCHIBALD BUCHAN HEPBURN of Smeaton, Bart., Haddington.
DAVID WILSON, D.Sc., of Carbeth, Killearn.
JOHN STIRTON, *Secretary.*

9. FORESTRY.

Sir ARCHIBALD BUCHAN HEPBURN of Smeaton, Bart., Haddington, *Convener.*
A. H. ANDERSON, Kippendavie, Dunblane.
JAMES I. DAVIDSON, Saughton Mains, Corstorphine.
CHARLES DOUGLAS, D.Sc., of Auchlochan, Lesmahagow.
LORD DUNGLASS, Springhill, Coldstream.
JOHN R. FINDLAY of Aberlour, 27 Drumsheugh Gardens, Edinburgh.
Major JOHN GILMOUR, M.P., yr. of Montrave, Pollok Castle, Newton Mearns.
DAVID KEIR, Ladywell, Dunkeld.
LORD LOVAT, C.B., D.S.O., &c., Beaufort Castle, Beauly
A. D. MACDONALD, Yester Estates Office, Gifford.
Right Hon. Sir HERBERT E. MAXWELL of Monreith, Bart., Whauphill.
Sir HUGH SHAW STEWART, Bart., C.B., of Greenock and Blackhall, Ardgowan.
Sir JOHN STIRLING MAXWELL of Pollok, Bart., Pollokshaws.
JOHN MICHIE, M.V.O., Balmoral, Ballater.
The MASTER OF POLWARTH, Humbie House, Upper Keith.
Brig.-General ARCHIBALD STIRLING of Keir, M.P., Dunblane.
DAVID WILSON, D.Sc., of Carbeth, Killearn.

10. OFFICE-BEARERS.

Constitution: (1) The four Ordinary Directors for the district in which the Show for the year is to be held (with the exception of one retiring next year); (2) one Ordinary Director from each of the other Show districts; and (3) the Chairman of the Board, Hon. Secretary, and Treasurer, *ex officiis.*

Edinburgh { G. B. SHIELDS, Dolphingstone, Tranent.
ROBERT PARK, Brunstane, Portobello.
JAMES ELDER, Athelstaneford Mains, Drem.

Aberdeen . JOHN P. SLEIGH, Strichen Mains, Strichen.
Border . GEORGE W. CONSTABLE, Traquair Estate Office, Innerleithen.
Dumfries . JAMES M'QUEEN of Crofts, Dalbeattie.
Glasgow . WILLIAM ELLIOT, Lanark.
Inverness . D. A. STEWART, Lochdhu, Nairn.
Perth . R. D. THOM of Pitlochie, Gateside.
Stirling . WILLIAM CARRICK, The Baad, Stirling.

CHARLES DOUGLAS, D.Sc., of Auchlochan, Chairman, *ex officio.*
ALEXANDER CROSS of Knockdon, Hon. Secretary, *ex officio.*
DAVID WILSON, D.Sc., of Carbeth, Killearn, Treasurer, *ex officio.*

REPRESENTATIVES ON OTHER BODIES.

National Agricultural Examination Board.

ALEXANDER CROSS of Knockdon, 19 Hope Street, Glasgow, *Chairman.*
CHARLES DOUGLAS, D.Sc., of Auchlochan, Lesmahagow.
Sir ARCHIBALD BUCHAN HEPBURN of Smeaton, Bart., Haddington.
DAVID WILSON, D.Sc., of Carbeth, Killearn.
JOHN STIRTON, Highland and Agricultural Society.

Edinburgh and East of Scotland College of Agriculture.

Sir ARCHD. BUCHAN HEPBURN of Smeaton, Bart., Haddington.
GEORGE G. MERCER, J.P., Southfield, Dalkeith.

West of Scotland Agricultural College.

Sir HUGH SHAW STEWART, Bart., C.B., of Ardgowan and Blackhall, Ardgowan, Greenock.
JOHN M'CAIG of Belmont, Stranraer.

Aberdeen and North of Scotland College of Agriculture.

WILLIAM DUTHIE, Tarves.
Dr J F. TOCHER, 41½ Union Street, Aberdeen.

Royal (Dick) Veterinary College.

Sir ARCHIBALD BUCHAN HEPBURN of Smeaton, Bart., Haddington.

Glasgow Veterinary College.

ALEXANDER CROSS of Knockdon, 19 Hope Street, Glasgow.

Scottish Milk Records Association.

ALEXANDER CROSS of Knockdon, 19 Hope Street, Glasgow.
JOHN M'CAIG of Belmont, Stranraer.
Sir HUGH SHAW STEWART, Bart., C.B., of Greenock and Blackhall.

MEETINGS.

General Meetings.—By the Charter the Society must hold two General Meetings each year, and, under ordinary circumstances, they are held in the months of January and June, in the Society's Hall, 3 George IV. Bridge, for the election of Members and other business. Twenty a quorum.

By a resolution of the General Meeting on 15th January 1879, a General Meeting of Members is held in the Showyard on the occasion of the Annual

Show. This year no meeting will be held, on account of the decision of the Directors not to proceed with the Show.

With reference to motions at General Meetings, Bye-Law No. 10 provides—"That at General Meetings of the Society no motion or proposal (except of mere form or courtesy) shall be submitted or entertained for immediate decision unless notice thereof has been given a week previously to the Board of Directors, without prejudice, however, to the competency of making such motion or proposal to the effect of its being remitted to the Directors for consideration, and thereafter being disposed of at a future General Meeting."

General Show at Edinburgh.—At the Meeting of the Board of Directors, on 29th November 1916, it was decided, on the unanimous recommendation of the Shows Committee, that no Show be held in 1917. (See Report of General Meeting—inside page of back cover.)

Directors' Meetings.—The Board of Directors meet (except when otherwise arranged) on the first Wednesday of each month from November till June inclusive, at half-past one o'clock P.M., and occasionally as business may require, on a requisition by three Directors to the Secretary, or on intimation by him. Seven a quorum.

Committee Meetings.—Meetings of the various Committees are held as required.

Nomination of Directors.—Meetings of Members, for the purpose of nominating Directors to represent the Show Divisions on the Board for the year 1918-1919, will be held at the places and on the days after mentioned :—

1. Edinburgh, Market Buildings, Gorgie, Wed., 30th Jan. 1918, at 2.
2. Cupar, ... Tues., 19th Feb. 1918, at 2.
   (*In* 1919 *the Meeting will be held in Cupar-Fife. In* 1920 *and* 1921 *the Meetings will be held at Perth.*)
3. Glasgow, North British Railway Hotel, Wed., 20th Feb. 1918, at 1.
4. Stirling, Golden Lion Hotel, . . Thur., 21st Feb. 1918, at 1.30.
5. Border, Railway Hotel, St Boswells, . Thur., 28th Feb. 1918, at 1.
6. Aberdeen, Imperial Hotel, . . . Fri., 1st Mar. 1918, at 2.30.
7. Inverness, Station Hotel, . . . Tues., 5th Mar. 1918, at 12.30.
8. Dumfries, King's Arms Hotel, . . Wed., 13th Mar. 1918, at 1.30.

The nomination of Proprietor or other Members paying the higher subscription must be made in the 4th, 6th, 7th, and 8th Divisions ; and the nomination of Tenant-Farmer or other Members paying the lower subscription, in the 1st, 2nd, 3rd, and 5th Divisions.

Retiring Directors are not eligible for re-election until after the lapse of at least one year.

EXAMINATIONS.

Agriculture.—The Examination for 1917 for the National Diploma in Agriculture will be held at the University, Leeds, on Saturday, 21st April, and following days. Entries close on 1st March.

Dairy.—The Examination for 1917 for the National Diploma in Dairying will be held at the Dairy School, Kilmarnock, on Friday, 21st September, and following days. Entries close on 15th August.

Forestry.—The Examination for the Society's Certificates in Forestry will be held at 3 George IV. Bridge, Edinburgh, on 27th, 28th, and 29th March 1917. Entries close on 26th February.

AGRICULTURAL EDUCATION

By a Supplementary Charter under the Great Seal, granted in 1856, the Society is empowered to grant Diplomas.

From 1858 to 1899 the Society held an annual Examination for Certificate and Diploma in Agriculture. In 1872 the Free Life Membership of the Society was granted to winners of the Diploma. In 1884 permission was given to holders of the Diploma to append the letters F.H.A.S. to their names.

In 1898 it was resolved by the Royal Agricultural Society of England and the Highland and Agricultural Society of Scotland to discontinue the independent Examinations in Agriculture held by the two Societies, and to institute in their stead a Joint-Examination for a NATIONAL DIPLOMA IN AGRICULTURE (N.D.A.) This Examination is now conducted under the management of the "National Agricultural Examination Board" appointed by the two Societies. In the year 1903, on the invitation of the two Societies, the Board of Agriculture and the Scotch Education Department agreed to appoint a representative from each to act on the Examination Board. Professor Middleton represents the former and Sir John Struthers, K.C.B, LL D, the latter body

REGULATIONS FOR EXAMINATION IN THE SCIENCE AND PRACTICE OF AGRICULTURE

REGULATIONS

1. The Societies may hold conjointly, under the management of the National Agricultural Examination Board appointed by them, an Annual Examination in the Science and Practice of Agriculture, at a convenient centre.

2. Candidates who pass the Examination will receive the National Diploma in Agriculture—the Diploma to be distinguished shortly by the letters "N.D.A."

3. The Examination will be conducted by means of written papers and oral Examinations.

4. In order to be eligible to sit for the Board's Examination in Agriculture, a Candidate must—

(*a*) Present a certificate from a recognised Agricultural College that his attainments in the subjects of *General Botany*, *Geology*, *General Chemistry*, *Physics and Mechanics*, as attested by class and other examinations, are, in the opinion of the authorities of the College, such as to justify his admission to the Board's Examination ; *or*

(*b*) Produce evidence that he has passed the 1st B.Sc. or the Intermediate Examination in Science of a British University ; *or*

(*c*) Present a Senior Certificate obtained at the Local Examinations of the Universities of Oxford or Cambridge, and produce evidence that he has continued his study of science for at least a year, and has

obtained a certificate in subject 3 (*a*) Elementary Chemistry and Physics, (*b*) Botany of Group H of the Oxford Higher Local Examination, *or* in Subjects 1, Elementary Chemistry and Physics, and 4, Botany of Group E of the Cambridge Higher Local Examination ; *or*

(*d*) Present an Intermediate Leaving Certificate of the Scotch Education Department, and produce evidence that he has continued his studies for at least another year and has obtained the Higher Leaving Certificate in Science (including Chemistry and Botany).

5. In the case of students who satisfy the Board that they have not had the facilities for obtaining the foregoing certificates, the Board will be prepared to consider evidence of equivalent attainment.

6. Candidates will have the option of taking the whole of the following eight papers at one time, or of sitting for a group of any three or four in one year and the remaining group of four or five in the next year.

SUBJECT.	Maximum Marks.	Pass Marks
1. Practical Agriculture (First Paper)	300	180
2. Practical Agriculture (Second Paper)	300	180
3. Farm and Estate Engineering— (*a*) Surveying (*b*) Farm Buildings (*c*) Machinery and Implements	300	150
4. Agricultural Chemistry	300	150
5. Agricultural Botany	300	150
6. Agricultural Book-keeping	200	100
7. Agricultural Zoology	200	100
8. Veterinary Science	200	100
	2100	1110

7. A Candidate who obtains not less than three-fourths (1575) of the aggregate maximum marks (2100) in the entire Examination will receive the Diploma with Honours, provided that he obtains not less than three-fourths (450) of the maximum marks (600) in the two Practical Agriculture papers.

8. Candidates electing to take the entire Examination at one time and failing in not more than two subjects may appear for these subjects in the following year. Failure in more than two subjects will be regarded as failure in the whole Examination.

9. Candidates electing to take the Examination papers in two groups and failing in a single subject may appear for that subject in the following year. Failure in more than one subject will be regarded as failure in the group.

10. Non-returnable fees must be paid by Candidates as follows :—

Entire Examination	Four guineas.
Group of Subjects	Two guineas.
One or two Subjects	One pound.

11. The Board reserve the right to postpone, abandon, or in any way, or at any time, modify an Examination, and also to decline at any stage to admit any particular Candidate to the Examination.

The Examination will take place at the Leeds University on SATURDAY, APRIL 21, 1917, and days of the following week.

Forms of application for permission to sit at the Examination may be obtained from "The Secretary, Royal Agricultural Society of England, 16 Bedford Square, London, W.C.," or from "The Secretary, Highland and Agricultural Society of Scotland, 3 George IV. Bridge, Edinburgh," and must be returned duly filled up not later than THURSDAY, MARCH 1, 1917, when the Entries will close.

16 BEDFORD SQUARE, LONDON, W.C.,
December 1916.

SYLLABUS OF SUBJECTS OF EXAMINATION

PRACTICAL AGRICULTURE.

I.—FIRST PAPER.

1. *British Farming.*—Arable, stock-raising, dairying—Approximate areas covered by the different systems—Typical examples of each—Area in Great Britain under chief crops—Numbers of live stock—The recent history of agriculture—Short summary of agricultural returns.

2. *Climate.*—The effect of climate on farming practice—Rainfall—Temperature—Prevailing winds—Weather forecasts.

3. *Soils.*—The influence of geological formations on the systems of farming—Classification of soils—Character and composition—Suitability for cultivation—Reclamation—Drainage—Irrigation—Warping—Application of lime and marl—Bare fallows—Tillage—Subsoiling—Deep and thorough cultivation.

4. *Manures.*—The manures of the farm—The treatment of farmyard manure—The disposal of liquid manure and sewage—General manures—Special manures—Field trials of manures—The application of manures—Period of application and amounts used per acre—Unexhausted value of manures and feeding-stuffs.

5. *Crops.*—Wheat, barley, oats, rye, beans, peas, potatoes, turnips, swedes, mangolds, forage plants, hops, and other crops—Their adaptation to different soils and climates—Varieties—Selection of seed—Judging seeds—Cultivation, weeds and parasitic plants, best methods of prevention and eradication—Harvesting—Storing—Cost of production—Improvement of crops by selection and hybridising—Field trials—Methods which the farmer may adopt—Selection to resist disease—The principles of rotations—Rotations suitable for different soils and climates—Rotations and the maintenance of fertility—Green manuring—Leguminous crops in rotation—Catch crops—The advantages and disadvantages of rotations—Specialised farming.

II.—SECOND PAPER.

6. *Live Stock.*—The different breeds of British live stock—Their origin, characteristics, and comparative merits—Suitability for different districts—Breeding—General principles—Selection—Mating—Crossing—Rearing and general management—Breeding and rearing of horses, cattle, sheep, pigs and poultry—Rearing colts and raising store stock—The foods of the farm—Their composition and suitability for different classes of stock—Purchased foods—Composition and special value—Rations for different kinds and ages of stock—Cost of producing beef, mutton, pork, and milk—Cost of feeding farm horses.

7. *The disposal of Crop, Produce, and Stock.*—Marketing grain and other crops—Sale of stock—Live weight—Dead weight.

8. *Milk.*—The production and treatment of milk—The manufacture of cheese, butter, &c.—The utilisation of by-products.

9. *Farming Capital.*—Calculations of the stocking and working of arable, stock, and dairy farms—Labour on the farm—Farm valuations—Rent and taxes.

10. *Renting a Farm.*—Indications of condition, productive power, and stock-carrying capacity—Leases—Conditions of occupancy.

N.B.—*It is essential that a Candidate know his subject practically, and that he satisfy the Examiner of his familiarity with farm routine.*

III.—FARM AND ESTATE ENGINEERING.

Surveying.

1. The use and adjustment of instruments employed in Surveying and Levelling.

2. Land surveying by chain—Plotting from field book, and determination of areas surveyed—The simpler "field problems."

3. Levelling and plotting from field book.

4. A sufficient knowledge of Trigonometrical Surveying for the determination of heights and distances by Theodolite.

5. A knowledge of the various classes of maps published by the Ordnance Survey Department and their Scales.

Farm Buildings.

6. *Roads, Fences, and Land Drainage.*—The construction and maintenance of farm roads, fences, and ditches—Drains, and cost.

7. *Buildings.*—Buildings required on different classes of farms—Economical arrangement of farm buildings—Materials—Construction—Ventilation—Drainage—Water supply—Dimensions of dairy, stables, cowsheds, yard, courts, and piggeries—Accommodation for power—Implement, machinery, and cart sheds—Hay and grain sheds—Shelter sheds—Storage of manure—Approximate cost of farm buildings for sizes of farms and system of farming.

Machinery and Implements.

8. *Power.*—The principle of action, construction, and method of working of steam, gas, and oil engines, petrol motors, and boilers—Estimation of the brake horse-power of engines—Care and management of engines and boilers—Power derived from water—Measurement of the quantity of water flowing in a stream—Water wheels—Turbines—Pumps, principle of action and construction—Flow of water through pipes—Windmills—Cost and working expenses in connection with the above.

9. *Agricultural Machinery.*—The mode of action and the general principles involved in the construction and working of farm implements and machinery—Pulleys and belting—Power transmitted by belts—Toothed gearing—Shafting and bearings—Lifting appliances—Strength and care of chains—Lubrication—Construction of simple concrete foundations for engines and machines.

10. *Implements of Harvesting.*—Reaping machines—Mowing machines—Rakes—Tedders—Sweeps—Elevators—Potato raisers.

11. *Implements of Transit.*—Carts, waggons, rick lifters, traction engines, motors.

12. *Threshing and Food-preparing Machinery.*—Threshing machines, screens, winnowers—Hummelers, chaff cutters—Pulpers—Cake breakers.

13. *Dairy Appliances.*—Milking machines—Cream separators—Churns and other butter-working appliances—Milk delivery cans—Cheese-making utensils—Vats and presses.

N.B.—*Each Candidate should have with him at the Examination a pair of compasses, scales of equal parts, including a scale of one chain to an inch, and the scale fitting the Ordnance map,* $\frac{1}{2500}$ *or* 25·344 *inches to the mile, a small protractor, a set square, and a straight-edge about* 18 *inches in length.*

Candidates are expected to have had some experience with agricultural machinery and implements under actual working conditions, and to be capable of illustrating their answers, when necessary, by intelligible sketches or diagrams.

IV.—AGRICULTURAL CHEMISTRY.

1. *The Atmosphere.*—Its composition and relations to plant and animal life.

2. *Water.*—Rain water—Soil water and drainage—Drinking water—Sewage and irrigation.

3. *The Soil.*—Origin, formation, and classification of soils—Sampling—Analysis—Composition of soils—The chemical and physical properties of soils—The water and air of the soil—Biological changes in the soil—The soil in relation to plant growth—Fertility—Causes of infertility—Improvement of soils.

4. *Manures.*—Theories of manuring—Classification of manures—Origin, nature, and characteristics of manures—Manufacture of manures—Composition, analysis, adulteration, and valuation of manures—Farmyard manure and other natural manures—Green-manuring—Liming, marling, claying—Artificial manures, their origin and manufacture—Fertilisers and Feeding Stuffs Act—Sampling of manures.

5. *Poisons, Antiseptics, and Preservatives.*—General chemical composition and character of insecticides, fungicides, antiseptics, and preservatives used on the farm.

6. *Plants and Crops.*—Constituents of plants—Assimilation and nutrition of plants—Sources of the nitrogen and other constituents of plants—Germination—Action of enzymes—Composition and manurial requirements of farm crops—Food products derived from crops—Manuring experiments.

7. *Animals.*—Composition of animal body—Animal nutrition—Digestion—Assimilation, metabolism, respiration, and excretion.

8. *Foods and Feeding.*—Constituents of foods—Origin, nature, and composition of chief feeding-stuffs—Sampling, analysis, and adulteration of foods—Nutritive value and digestibility of food—Functions of chief food constituents—Energy values—Relation of foods to the production of work, meat, milk, and manure—Manurial residues of foods.

9. *Dairy Chemistry.*—The composition of milk, cream, butter, cheese, &c.—Conditions which influence the composition of milk and milk products—Action of ferments and enzymes on milk and milk products—Milk-testing—Analysis and adulteration of dairy products.

N.B.—*Candidates are required to bring their Laboratory Notes to the Oral Examination in this subject.*

V.—AGRICULTURAL BOTANY.

In addition to a general knowledge of the morphology, histology, and physiology of plants, candidates will be expected to possess a detailed knowledge of the following subjects:—

British grasses of agricultural importance: recognition of at any stage of growth. Habitats of important species. Constitution of the grass flora of good meadows and pastures. Composition of seed mixtures for temporary and permanent leys on various soils. The effects of artificial manures on the flora of grass land.

The weeds of arable and grass land. Poisonous and parasitic weeds. Methods of distribution by seed and vegetatively: of eradication. Weeds as soil indicators. Recognition of the seeds of the common weeds, particularly those characteristically found in clover, grass, &c., seed.

The chief varieties of wheat, barley, oats, clovers, roots, and other farm crops: their suitability for various climatic and soil conditions. The identification of the more important types of cereals by means of their grain characters. Characteristics of good and bad samples of cereals.

Materials used in feeding-cakes and meals: identification of.

Grafting, pruning, and the management of orchards.

Plant-breeding. Principles of heredity in plants. Pure lines. Fluctuating variability. Selection.

Disease in plants. Diseases due to the attacks of parasitic fungi. Resistance to disease: conditions affecting. The life-history of the more important species of Plasmodiophora, Synchytrium, Phytophthora, Peronospora, Sphærotheca, Nectria, Claviceps, Sclerotinia, Ustilago, Tilletia, Puccinia, Polyporus, Armillaria, and of any fungoid diseases scheduled from time to time by the Board of Agriculture and Fisheries.

Yeasts and fermentation.

The general outlines of bacteriology: nitrogen fixation, nitrification, and denitrification. Putrefaction and the bacteriology of milk, butter, and cheese.

VI.—AGRICULTURAL BOOK-KEEPING.

Principles of book-keeping; single and double entry; opening books, description of subsidiary books, with examples of entries therein; the ledger; posting; preparation of trial balance; valuation of stocks and effects; closing and proving the books, preparation of profit and loss account and balance-sheet; ruling off accounts.

Application of special methods to farms of varying requirements.

VII.—AGRICULTURAL ZOOLOGY.

1. The part played by common animals in helping or hindering agricultural operations, as illustrated by moles and voles, insectivorous and other birds, snails and slugs, useful and injurious insects, arachnids and myriapods, earthworms, &c.

2. *General Structure of Insects*, especially the external characters.

3. *Life-history of Insects.*—Economic importance of different stages. A knowledge of the life-history of the principal insect pests as affording a basis for appropriate treatment.

4. *Classification of Insects.*—The general characters of the following Natural Orders: Coleoptera, Lepidoptera, Hymenoptera, Diptera, Hemiptera, Orthoptera, Neuroptera.

5. *Acarina* injurious to Food Crops and Live Stock.
6. *Parasitic Worms.*—Flukes, Tapeworms, and Threadworms.
7. *Preventive and Remedial measures* in regard to insects, acarines, and worm Parasites—*e.g.*, farm practice in relation to the discouragement of Insect Attack. Encouragement of insect-eating birds and mammals. Artificial remedies. Insecticides. Treatment for Parasites.

N.B.—*Practical acquaintance with common animals, especially insects and worm parasites, will be expected. Where the Candidate is not acquainted with the scientific name of an animal, the generally received English name will be accepted. Candidates are required to bring their Laboratory Notes to the Oral Examination in this subject.*

VIII.—VETERINARY SCIENCE.

1. Elementary Anatomy and Physiology of the horse, ox, sheep, and pig.
2. The general principles of breeding—including the physiology of reproduction, the laws of heredity, the periods of gestation, and the signs of pregnancy in the mare, cow, ewe, and sow.
3. Dentition as a means of determining the age of horses, cattle, sheep, and swine.
4. The management of farm stock in health and disease.

The following won the Diploma in 1916 :—

James Alexander Barbour, Harper-Adams Agricultural College, Newport, Salop.
Harry B. Bescoby, Guestling, Hastings.
Robert Campbell Broadfoot, West of Scotland Agricultural College, Glasgow.
John Dempsey, Royal College of Science, Dublin.
Herbert Caldwell James, Harris Institute, Preston.
Joseph W. Kirkham, Midland Agricultural and Dairy College, Kingston, Derby.
John Wilson Reid, West of Scotland Agricultural College, Glasgow.
John George Rhynehart, Royal College of Science, Dublin.
Arthur Musgrave Smith, Leeds University.
Narayan R. K. R. Zanane, Downing College, Cambridge.

No candidate on this occasion reached the honours standard.

Examination Papers of Past Years.

Copies of the Papers set at the Annual Examinations for the National Diploma in the Science and Practice of Agriculture, held from 1905 to 1917, may, so far as available, be had upon application. Price 6d. per set.

VETERINARY DEPARTMENT

The Society established a Veterinary Department in 1823, but by an arrangement made with the Royal College of Veterinary Surgeons, the Society's examination ceased in 1881. Holders of the Society's Veterinary Certificate are entitled to become Members of the Royal College of Veterinary Surgeons on payment of certain fees, without being required to undergo any further examination. The number of Students who passed for the Society's Certificate is 1183.

The Society votes annually eleven silver medals for Class Competition to each of the two Veterinary Colleges in Scotland, the one in Edinburgh and the other in Glasgow.

FORESTRY DEPARTMENT

THE Society grants FIRST and SECOND CLASS CERTIFICATES in FORESTRY.

1. An Examination will be held each alternate year about the month of April.

2. Next Examination will be held on 27th, 28th, and 29th March, 1917. Entries close on 26th February.

3. Candidates must possess—1. A thorough acquaintance with the theory and practice of Forestry. 2. A general knowledge of the following branches of study, so far as these apply to Forestry: (*a*) The Elements of Botany and Forest Zoology; (*b*) The Elements of Physics, Chemistry, and Meteorology; (*c*) Forest Engineering, including Land and Timber Measuring and Surveying; Mechanics and Construction, as applied to fencing, draining, bridging, road-making, and saw-mills; and Implements of Forestry; (*d*) Book-keeping and Accounts.

4. The examinations are open to candidates of any age, may be both written and oral, and will include such practical tests as may from time to time be decided to apply.

5. The maximum number of marks for each subject is 100; Pass marks for First-Class Certificate—Forestry, 75; all other subjects, 60. Pass marks for Second-Class Certificate—Forestry, 60; all other subjects, 50.

6. A Candidate who obtains Pass marks in certain subjects, but fails in others, may come up for these other subjects alone, it being understood that without the special permission of the Society no Candidate will be eligible to enter for more than two subsequent examinations.

7. A Candidate who has obtained the Second-Class Certificate may enter again for the First-Class Certificate.

The list of students who obtained certificates prior to 1899 appears in the 'Transactions,' Fifth Series, vol. xi. (1899).

The following have since obtained First-Class Certificates:—

ERIC ARTHUR NOBBS, Department of Agriculture, Cape Town, ... 1899
GEORGE POTTS, Grey College, Bloemfontein, Orange River Colony, ... 1899
DUNCAN S. RABAGLIATI, 1 St Paul's Road, Bradford, . 1901
FRANK SCOTT, Dumfries House Mains, Cumnock, . . 1903
WILLIAM T. STOCKLEY, Rose Villa, Garswood, near Wigan, 1906
A. FRANK WILSON, C.D.A. (Edin.), Reedieleys, Auchtermuchty, ... 1907
GEORGE FISHER, Farm Brook, Pilling, Garstang, Lancs., . 1909
JOHN PATTEN, jun., Hulne Park, Alnwick, ... 1909
ALEXANDER MITCHELL, Dalmeny Park, Edinburgh, . 1909
JOHN D. DAVIDSON, Brimstage, Birkenhead, . . . 1911

Donald Doull, M.A., A.R.C.Sc., High School, Kelso, . 1911
James W. Mackay, Jervaulx Abbey, Middleham, Yorks., 1915
Harry Watson, Darnaway, Forres 1915

The following have since obtained Second-Class Certificates :—

William Bruce, B.Sc., East of Scotland College of Agriculture, Edinburgh, ... 1901
Rajappier Swaminathan, 56 Jesus Lane, Cambridge, . 1901
Thomas Usher, Courthill, Hawick, ... 1901
Allan Carruth, Lawmarnock, Kilbarchan, . . . 1905
Alex. M. Lumsden, Newburn Schoolhouse, Upper Largo, 1905
Robert M. Wilson, Laws Cottage, Duns, . . . 1905
Thomas Campbell, Greystoke, Penrith, ... 1906
Donald Ferguson, Quarry Lane, Lennoxtown, . . 1906
Charles Penrhyn Ackers, Huntly Manor, Gloucester, 1908
Robert Howie, Beechwood, Arbroath, ... 1908
John Trotter, D.Sc., 22 West Saville Terrace, Edinburgh, 1908
James A. S. Watson, Downieken, Dundee, . . . 1908
Norman H. Pearson, 52 Percy Park, Tynemouth, . . 1909
Lionel F. Stobart, Royal Agricultural College, Cirencester, ... 1911
Alexander George Norrie, Cairnhill, by Turriff, . . 1913
William Watt, Darnaway, Forres, ... 1913
William P. Greenfield, 6 Littlefield Lane, Grimsby . 1915

SYLLABUS OF EXAMINATION

I.—SCIENCE OF FORESTRY AND PRACTICAL MANAGEMENT OF WOODS.

I. *Principles of Scientific Forestry.*—1. Effects of heat, light, moisture, and air-currents on forest vegetation. 2. Effects of depth, porosity, moisture, and chemical composition of the soil on forest vegetation. 3. Effects of forest vegetation on the soil and air. 4. Rate and extent of development, longevity, and reproductive power of trees. 5. Pure and mixed woods. 6. Systems of sylviculture.

II. *Forest Organisation.*—7. General ideas regarding a regulated system of forest management. 8. Knowledge of working plans of forests.

III. *Practical Management of Woods.*—9. Draining and irrigation. 10. Choice of species for various situations. 11. Seed and sowing, including nurseries. 12. Planting. 13. Natural regeneration by seed, shoots, and suckers. 14. Formation of mixed woods. 15. Tending of young woods. 16. Pruning. 17. Thinning. 18. Sylvicultural characteristics of the principal trees.

IV. *Injuries by Storms and Fires.*—19. Storms. 20. Fires.

V. *Timber.*—21. Its technical properties. 22. Its defects. 23. Recognition of different kinds of timber. 24. Processes for increasing its durability.

VI. *Utilisation of Produce.*—25. Uses of wood and other produce. 26. Felling. 27. Conversion. 28. Seasoning. 29. Transport. 30. Sales. 31. Harvesting of bark.

II.—FOREST BOTANY AND FOREST ZOOLOGY.

(a) Forest Botany.

The fundamental facts of morphology, physiology, and classification of plants. The structure and function of the plant-cell and the plant-tissues. Their primary distribution. The secondary changes they exhibit in consequence of perennation.

The structure and function of the root and shoot in flowering-plants. Buds, their forms and uses. The flower. The fruit. The seed.

The structure and function of vegetative and reproductive organs of fungi.

Relationship of plants to air, soil, and water. Effect of light, heat, and mechanical agencies upon plants. Nutrition. The nature and elements of the food of plants. Sources of plant-food. The absorption, elaboration, transference, and storage of food. Respiration and transpiration. Parasites and saprophytes. Symbiosis.

Growth of plants in length and thickness. Correlation of growth, pruning. Germination of seeds. Formation of wood and bark. Healing of wounds.

Diseases of plants due to faulty nutrition and unfavourable circumstances of growth. Diseases due to attacks of fungi.

Natural reproduction and propagation by seeds and by buds. Fertilisation of flowers. Hybridisation. Artificial propagation by budding, grafting, layering, and cutting.

The characters of the large groups and classes of the vegetable kingdom. The characters of the families of plants which include the chief timber trees. The botanical characteristics of the principal British forest-trees (including the structural features of their wood). The weeds of the forest and their significance.

(b) Forest Zoology.

The group Insecta: its position in the animal kingdom. Structure, mode of reproduction, and metamorphosis of insects. The outlines of classification of the group. Conditions favourable to the numerical increase of insects. Natural checks to increase (*e.g.*, birds, mammals, parasitic insects). The identification and life-history of the more important insects injurious to forest-trees and fruit-trees. The damage caused by these insect pests and their mode of attack. The damage caused by animals. Preventive and remedial measures.

III.—PHYSICS, CHEMISTRY, AND METEOROLOGY.

Physics.

Mass, weight, specific gravity, solid, liquid, and gaseous states of matter. Capillarity, osmose, vapour tension, suction pump, force pump, syphon, barometer, atmospheric pressure. Boyle's law. Levers and pulleys. Heat, measurement of heat, specific heat; transference of heat by conduction, convection, and radiation. Boiling and freezing. Latent heat. The thermometer. The conservation and transformation of energy. Light—reflection, refraction, polarisation; the spectrum. The rudiments of electricity and magnetism.

Chemistry.

Elements. Oxygen, hydrogen, nitrogen,—their preparation, properties, and chief compounds. Acids, bases, salts. Combustion, oxidation, reduction. Sulphur, carbon, phosphorus; and their compounds, with oxygen and hydrogen. Metals—potassium, sodium, calcium, magnesium, aluminium, iron, copper, lead, mercury, and their chief compounds. Carbohydrates, marsh gas, olefiant gas, alcohol, acetic acid, oxalic acid. Distillation of wood and coal.

Meteorology.

The atmosphere, its composition and physical properties. Measurement of pressure and temperature. The barometer. Rain, hail, snow, fog, cloud, dew, the dew-point, hoar frost. The weathering of rocks and soils. Gases injurious to vegetation.

IV.—FOREST ENGINEERING, INCLUDING LAND AND TIMBER MEASURING AND SURVEYING; MECHANICS AND CONSTRUCTION AS APPLIED TO FENCING, BRIDGING, ROAD-MAKING, AND SAW-MILLS.

1. The use of the level and measuring-chain. Measuring and mapping surface areas. 2. The measurement of solid bodies—as timber, stacked bark, fagots, &c., earthwork. 3. The different modes of fencing and enclosing plantations; their relative advantages, durability, cost of construction, and repairs. 4. The setting out and formation of roads for temporary or permanent use. 5. The construction of bridges over streams and gullies; of gates or other entrances. 6. The construction and working of estate saw-mills.

V.—ARITHMETIC—BOOK-KEEPING.

1. Arithmetic—including Practice, Proportion, and Decimal Fractions. 2. Book-keeping—including the description of books to be kept, and the solution of practical questions in Book-keeping and the preparation of Accounts.

EXAMINATION PAPERS

PRACTICAL FORESTRY.

1. Describe the working plan of any woodland with which you are familiar, drawing attention to any defects, and point out how these might be remedied.

2. How would you be guided in deciding what species of trees you would select (*a*) to re-stock a newly cleared area, (*b*) to plant a stretch of rough hill pasture of varying quality?

3. In planting an area of 200 acres with Larch, Corsican pine, Spruce, Sitka Spruce, and Douglas, how would you proceed to make the most of each species? Name any other species you would introduce, and give your reasons for doing so.

4. (*a*) What benefits are derived from drainage, and what method and system of drainage would you adopt (1) on gently sloping peaty land, (2) on a wet clay loam steep slope? (*b*) What are the objects and benefits of thinning?

5. (*a*) How would you know if a wood (1) 20 years old, (2) 50 years old, had a satisfactory degree of density? (*b*) What effect has under-stocking (1) on the individual tree, (2) on the crop in general? (*c*) How would you treat a 15-year-old plantation composed of an irregular mixture of Larch, Scots pine, Spruce, and Douglas?

6. Describe the plant you would recommend for an extensive property, having a good working plan for the woods, containing an abundance of varied marketable timber, which it is proposed will be utilised, as far as required, for estate purposes. How would you dispose of surplus timber?

(*Three hours allowed.*)

FOREST BOTANY AND FOREST ZOOLOGY.

(*A*) FOREST BOTANY.

(Four *questions only to be attempted.*)

1. Write a life-history of the Larch.

2. Give a general account of the Vascular System of a Dicotyledonous stem.

3. What are the essential features in the structure and mode of life of Fungi?

4. Compare and contrast Hazel, Lime, and Elm in (*a*) structure of flowers, (*b*) pollination, (*c*) dispersal of seed.

5. Draw and name the parts of a three-year-old branch of a broad-leaved forest tree. State the function of each part named.

(*B*) FOREST ZOOLOGY.

(Two *questions only to be attempted.*)

1. Give the round of life of any Aphid known to you as a pest on a forest tree.

2. What are the chief insect enemies of the Pine? Describe in detail any one of them.

3. How would you recognise and distinguish the damage of the following: Beech Weevil (Orchestes fagi), Squirrel, Osier Weevil (Cryptorhynchus lapathi), Crossbill, Rabbit, Field Vole?

(*Two hours allowed.*)

PHYSICS, CHEMISTRY, AND METEOROLOGY.

1. Explain the meaning of the terms "acids, bases, and salts." Describe the properties of each class, and give examples from substances containing calcium and phosphorus.

2. Describe how the destructive distillation of wood may be carried out. State briefly what you know of the composition and value of the distillate. Compare the volatile products with those obtained from the destructive distillation of coal.

3. What is meant by atmospheric pressure, and how would you determine it? Is atmospheric pressure constant, and if not, what are the chief causes of its variation in any locality?

4. What do you understand by the term "element"? Name the chief properties of elements, classifying into groups those with like properties.

5. Name the chief factors which operate in bringing about the reduction of rocks to soil. Describe separately the mechanical and chemical agencies, and give an example of the operation of each in the process of weathering.

(An hour and a half allowed.)

FOREST ENGINEERING.

1. The following notes from a Field Book refer to measurements taken for the purpose of estimating the quantity of earth to be excavated in connection with the construction of a road.

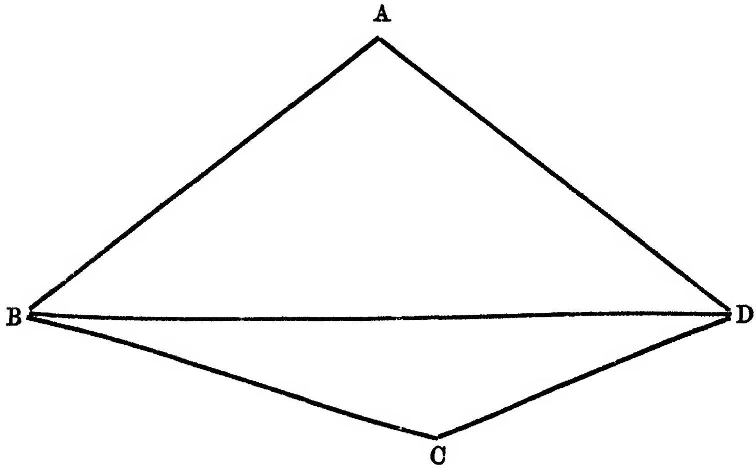
One side is vertical, and the opposite side has a slope of $1\frac{1}{2}$ to 1. The width at the bottom is 18 feet, and the total length is 210 feet, which may be assumed to be divided into three equal parts, and the measurements made at the middle of each part.

Make a dimensioned sketch of each section, and calculate the total amount of earth to be excavated in cubic yards.

Rise.	B.S.	I.S.	F.S.	Fall.	Reduced Level.	Remarks.
	12·86				O.	1st Section.
		8·26				
		6·59				
			5·85			
	10 96				O.	2nd Section.
		7·03				
		6·99				
			6·72			
	8·90				O.	3rd Section.
		6·84				
		7·05				
			6·26			

2. Draw the plan of a field from the following notes to a scale of 1 chain to the inch, and find the area of the field (see fig. 1).

Fig. 1.



Also measure the length of the perpendicular from A to BD.

	Links.
	⊙ D
	820
	630
0	500
45	390
30	250
	⊙ A

	⊙ A
	760
42	450
25	310
	⊙ B

⊙ D
5 40
⊙ C
⊙ C
610
⊙ B
⊙ B
1050
⊙ D

3. Make up the following Level Book. Plot the section to a horizontal scale of 1 inch to 1 chain and a vertical of 1 inch to 10 feet.

Rise.	B.S.	I.S.	F.S.	Fall.	Reduced Level.	Distance Links.	Remarks.
	1·52				30		B.M.
	7·48		8·62			0	O A
		10·71				120	
	5·91		13·56			250	
		8·65				340	
	9·44		6·37			480	
		8·13				580	
		6·28				680	
	8·38		4·19			800	
		5 41				930	
		3 25				1050	
	6·65		0 73			1200	
		8·29				1360	
			11·53			1550	O B

4. Describe, with the aid of diagrams, how you would proceed in the field in order to find the height of an object :—

(*a*) The base of which you can approach.

(*b*) The base of which is inaccessible.

5. Give dimensioned sketches, showing in cross-section a macadamised road :—

(*a*) On a bank.

(*b*) In a cutting.

(*c*) On the side of a hill having a steep sidelong slope.

How would you provide for drainage?

6. Describe and sketch the general arrangement of a portable saw-milling plant.

How is the timber brought to, and taken from, the saw?

ARITHMETIC AND BOOK-KEEPING.

I. Arithmetic.

1. A piece of timber is 19 feet 6 inches long, 16 inches broad, and 10½ inches deep. Its cost is £2, 11s. 6d. Find the cost per cubic foot, stating the pence to three places of decimals.

2. Find by practice the value of 211 tons 11 cwt. 37 lb. @ 9s. 4d. per cwt.

3. A purchases a quantity of timber and sells it to B at a profit of 8 per cent. B sells the same timber to C at a profit of 10 per cent. What profit per cent would A have made if he had sold the timber direct to C at a price the latter paid to B? State your answer in decimals.

4. A rectangular piece of ground 200 yards long and 80 yards broad is to be planted with young trees. The trees are to be 12 feet apart, and there is to be a space of 6 feet between the outermost trees and the boundaries. How many trees are required?

II. Book-keeping.

You are the forester on the estate of Craigbeck. At 1st June 1914 the balance in bank was £53, while the cash on hand was £7, and there was a sum of £159 due to the estate by Alexander Black. The following are your transactions during the month of June 1914:—

1914.
June 1. Sold to Alexander Black on credit 1000 larch trees @ 8s. 6d.
" 2. Paid cash for carriage, to be recovered from Alexander Black, £5.
" 4. Sent cheque to Peter Jones in settlement of his account of £40 for implements, less discount at 5 per cent.
" 7. Received rent of cottage, £8 in cash.
" 9. Purchased from Alexander Black a brown horse the price of which, £40, it is arranged shall be set against his account.
" 11. Received from auctioneer and paid into bank cheque p. £155, being net proceeds of sales by him.
" 15. Received and paid into bank Alexander Black's cheque in settlement of his account to date, allowing him £5 discount.
" 18. Sent to proprietor cheque p. £250.
" 23. Paid for young trees by cheque, £18.
" 30. Drew from bank £20.
Paid salary and wages, £17.

(1) Write up Alexander Black's account in the Ledger.

(2) Write up the cash book, keeping separate columns for bank, cash, and discount, and showing the balances in bank and on hand at 30th June.

(*One hour and a half allowed.*)

DAIRY DEPARTMENT

EXAMINATION IN THE SCIENCE AND PRACTICE OF DAIRYING

This Examination, instituted in 1897, is conducted by the National Agricultural Examination Board, appointed jointly by the Royal Agricultural Society of England and the Highland and Agricultural Society of Scotland.

REGULATIONS.

1. The Societies may hold annually in England and in Scotland, under the management of the National Agricultural Examination Board appointed by them, one or more Examinations for the National Diploma in the Science and Practice of Dairying; the Diploma to be distinguished shortly by the letters "N.D.D."

2. The Examinations will be held on dates and at places from time to time appointed and duly announced. (*Note.*—This year one examination only will be held for both English and Scottish students at the University College and British Dairy Institute, Reading).

3. A non-returnable fee of *Two Guineas* will be required from each candidate.

4. Forms of application for permission to sit at the Examination may be obtained from "The Secretary, Royal Agricultural Society of England, 16 Bedford Square, London, W.C," or from "The Secretary, Highland and Agricultural Society of Scotland, 3 George IV. Bridge, Edinburgh," and must be returned duly filled up, with the entry-fee of £2, 2s., on or before August 15, 1917.

5. As a preliminary to the acceptance of an application for permission to enter for the Examination, a candidate must produce:—

(1) A certificate testifying that he or she has received at least SIX session months instruction (not necessarily continuous) in practical dairy work at an approved Dairy training institution.

(2) Evidence that he or she has spent at least SIX months on an approved Dairy farm (which period must not run concurrently with that referred to in sub-section 1), and that he or she has taken part in the work.

(3) Certificates in a prescribed form, from a recognised institution (or recognised institutions) showing that he or she has attended approved courses in Chemistry, Bacteriology, and Botany, and has satisfied the authorities of the institution of his (or her) fitness for admission to the Examination.

6. In the Examination a candidate will be required to satisfy the Examiners, by means of written papers, practical work, and *vivâ voce*, that he or she has—

(1) A general knowledge of the management of a Dairy Farm, including the rearing and feeding of Dairy Stock, the candidate being required to satisfy the Examiners that he or she has had a thorough training and practical experience in all the details of Dairy work as pursued on a farm.

(2) A thorough acquaintance, both practical and scientific, with everything connected with the management of a Dairy, and the manufacture of Butter and Cheese.

(3) Practical skill in Dairying, to be tested by the making of Butter and Cheese.

Note.—A candidate must be prepared to make any one of the following varieties of Hard-pressed Cheese, the Examiner in Cheesemaking having the option of saying during the Examination what variety a candidate shall make:—

At the English Centre—Cheddar, Cheshire, or Derby.

At the Scottish Centre—Cheddar, Dunlop, or Cheshire.

(4) Capacity for imparting instruction to others.

7. The Board reserve the right to postpone, to abandon, or in any way, or at any time, to modify an Examination, and also to decline at any stage to admit any particular candidate to the Examination.

DATES OF EXAMINATIONS IN 1917.

ENGLAND—Saturday, September 15th, and following days, at the University College and British Dairy Institute, Reading; last date for receiving applications, Wednesday, August 15th.

SCOTLAND—Friday, September 21st, and following days, at the Dairy School for Scotland, Kilmarnock; last date for receiving applications, Wednesday, August 15th.

SYLLABUS OF SUBJECTS OF EXAMINATION IN THE SCIENCE AND PRACTICE OF DAIRYING

I.—GENERAL MANAGEMENT OF A DAIRY FARM.

1. *General Management of Pastures and Crops on a Dairy Farm.*

2. *Buildings.*—Situation, Surroundings, Construction, Ventilation, and Drainage of Farm Buildings. Suitability of building materials. Water supply. Construction and arrangement of Dairies: (*a*) for General Purposes; (*b*) for Special Purposes.

3. *Foods and Feeding.*—Summer and Winter Feeding of Dairy Cattle. Root crops. Green fodder. Ensilage. Different kinds of food and their composition. Their effect upon Milk, Butter, and Cheese. Special Foods used in Dairy Feeding. Preparation of food for Dairy Stock. Rearing and feeding of young Stock. Feeding and management of Pigs and Poultry.

4. *Dairy Cattle in Health and Disease.*—Characteristics of different Breeds, and choice of Dairy Cattle. General functions of the organs of the animal body. Breeding. Parturition. Organs which secrete milk. Process of milk secretion. Changes which food undergoes during digestion. Diseases of Dairy Cattle and their remedies.

II.—MANAGEMENT OF DAIRY.

1. *Milk and Cream.*—Process of Milking. Dairy Utensils and Appliances, hand and power. Cooling of Milk. Separation and ripening of Cream. Different systems of Cream-raising. Utilisation of Skim-milk. Keeping of Milk. Importance of Cleanliness. Diseases spread by Milk. Conveyance and sale of Milk. Milk records. Keeping of Dairy and Farm Accounts. Creameries. Butter and Cheese Factories. Different systems of Dairying and their comparative returns.

2. *Butter.*—Churns and other Butter-making appliances, hand and power. Souring of Cream. Churning. Washing and working of Butter.

Butter-milk. Packing and transmission of Butter. Salting and keeping of Butter. Colouring. Characteristics of good Butter.

3. *Cheese.*—Principles of its manufacture. Making of different kinds of Cheese (from cream, whole-milk, and skim-milk). Acidity of Milk. Use of Rennet and its substitutes. Whey. Appliances for Cheese-making. Ripening and storage of Cheese. Packing and sale of Cheese. Making of Cream and other soft Cheeses.

III.—CHEMISTRY AND BACTERIOLOGY.

[*N.B.*—In this Section there will be expected of the candidate a sound understanding of the scientific principles underlying the practice of Dairying, a knowledge of the composition, nature, properties, and changes undergone by the different substances met with in Dairying, and a general acquaintance with the principles of laboratory methods so far as Dairying is concerned.]

1. *General Principles of Chemistry.*—The nature of elements and compound bodies. The different forms of matter—solid, liquid, gaseous. Specific gravity, and instruments for determining it. Temperature, and methods of measuring it. Thermometric scales. The influence of temperature in Dairy operations. Physical and chemical changes involved in the following: solution, precipitation, filtration, distillation, oxidation, and reduction. Acids, Bases, Salts—their distinctive properties. Acidity and Alkalinity—their influence and quantitative estimation.

The Atmosphere—its constituents and impurities; its influence on Dairy operations. Atmospheric pressure.

Water—constituents of pure and natural waters. The impurities of water, and whence derived. The importance of a pure water supply in Dairying.

General knowledge of the elementary chemistry of the following substances and their compounds so far as met with in Dairying: Potash, Soda, Ammonia, Lime, Phosphoric Acid, Alcohol, Acetic Acid, Carbonic Acid, Butyric Acid, Lactic Acid, Albumen, Casein, Fats, Milk-sugar, Glycerine, Pepsin.

Saponification of Fats.

2. *Milk and its Products.*—The nature, composition, properties, and chemical constituents of milk. Microscopical appearances presented by milk. The circumstances that affect the quality and quantity of milk produced by the cow. The influence of feeding. The changes which occur in the keeping of milk, and how produced. The natural and artificial souring of milk. Rennet, its nature and use. Physical and chemical changes involved in the making and keeping of Butter, and in the manufacture and ripening of Cheese. Separated Milk, Condensed Milk, Fermented Milk. The use of Preservatives. Methods of Milk-testing—Mechanical methods, their theory and practice. A general knowledge of the methods employed in the chemical analysis of Milk and Butter. Adulteration of Milk, Cream, Butter, and Cheese—the ways in which adulteration is practised, the changes in composition thereby produced, and a general knowledge of the methods employed in detecting the same.

3. *The Chemistry of Feeding.*—The principal constituents of Food materials, and the functions they severally fulfil. The influence of Food constituents on milk production. Assimilation and Digestion. Animal Heat and Respiration. Milk as a Food. The relation of Food to Manure.

4. *Bacteriology.*—Moulds. Yeasts. Bacteria. The principal kinds of Bacteria met with in Dairying—their forms, methods of reproduction, and conditions of life. The influence of physical agencies upon Bacterial

life. Air and Water as carriers of Bacteria. The changes produced by Bacteria in milk and its products. Useful forms and their functions. Harmful forms and their effects—Coagulation, Discoloration, Taints, &c. Pathogenic organisms. The classification of organisms—organised ferments and enzymes. The isolation of Bacteria. Methods of preparation of pure cultures and their practical use. Nutritive media. Soil Bacteriology—Assimilation of Nitrogen by Plants—Nitrification—Denitrification. Pasteurisation and Sterilisation — the practical application of these to Dairy matters. Fermentation and Putrefaction. Disinfectants and Preservatives.

N.B.—*Candidates are required to bring their Laboratory Notes to the Oral Examination in this subject.*

IV.—PRACTICAL SKILL IN DAIRY WORK.

Candidates must be prepared—(1) to produce at or before the Examination a satisfactory certificate of proficiency in the Milking of Cows, signed by a practical Dairy Farmer, and to satisfy the Examiners by a practical test, if so required ; (2) to churn and make into Butter a measured quantity of Cream ; and (3) to make one Cheese of each of the following varieties : (i) *Hard-pressed, of not less than 30 lb.; (ii) Veined or blue-moulded, of not less than 10 lb ; and (iii) also to make one or other of the following Soft Cheeses : Cambridge, Camembert, Coulommier, or Pont l'Evêque.

* A candidate must be prepared to make any one of the following varieties of Hard-pressed Cheese :—

English Students—Cheddar, Cheshire, or Derby.

Scottish Students—Cheddar, Dunlop, or Cheshire.

The Examiner in Cheesemaking will intimate the kind of Cheese to be made during the Examination.

V.—CAPACITY FOR IMPARTING INSTRUCTION TO OTHERS.

Candidates must also show practically that they are familiar with the management of a Dairy, and are capable of imparting instruction to others.

The following obtained the Diploma in Scotland in 1916 :—

Lizzie Beveridge, Fullwood Farm, Stewarton.
Catherine Campbell Jackson, Arichonan, Lochgilphead.
Margaret Elizabeth Jenkins, Llantwit Vardre Vicarage, Pontypridd.
Mary Lochrie, West Kirkland, Wigtown.
Elizabeth Mollins, Gibbonhill, Troqueer, Dumfries.
Annie Prichard, Cefn Caernan Uchag, Caerphilly.
Bessie Robertson, Belerlain, Dunphail.
Adelaide M. Thomson, Redford, Laurencekirk.
Marion Weir, Westmains, Carnwath.
Mary Young, Pleasantfield, Ayr.

The following obtained the Diploma in England in 1916 :—

Ethel Booth, Lancs. C.C. Dairy School, Hutton, Preston.
Margaret Howard, Midland Agricultural and Dairy College, Kingston, Derby.

Edith Blanche Hudson, Lancs. C.C. Dairy School, Hutton, Preston.
Joseph William Kirkham, Midland Agricultural and Dairy College, Kingston, Derby.
Agnes Muriel Barrow Musson, Lancs. C.C. Dairy School, Hutton, Preston.
Margaret Phillips, University College of Wales, Aberystwyth.
Doris Postlethwaite, Lancs. C.C. Dairy School, Hutton, Preston.
Walter Rushton, University College and British Dairy Institute, Reading.
Mary. Forshaw Taylor, Midland Agricultural and Dairy College, Kingston, Derby.
Gertrude Mary Weatherall, Midland Agricultural and Dairy College, Kingston, Derby.
Mildred Roberts Spenser Wilkinson, University College and British Dairy Institute, Reading.

Examination Papers of Past Years.

Copies of the Papers set at the Annual Examinations for the National Diploma in the Science and Practice of Dairying held from 1896 to 1916, may, so far as available, be had on application. Price 6d. per set.

CHEMICAL DEPARTMENT

Chemist to the Society—J. F. Tocher, D.Sc., F.I.C., Crown Mansions, 41½ Union Street, Aberdeen.

The object of the Chemical Department is to promote the diffusion of a knowledge of Chemistry as applied to agriculture among the members of the Society, to carry out experiments for that purpose, to assist members who are engaged in making local experiments requiring the direction or services of a chemist, to direct members in regard to the use of manures and feeding-stuffs, to assist them to put the purchase of these substances under proper control, and in general to consider all matters coming under the Society's notice in connection with the Chemistry of Agriculture.

MEMBERS' PRIVILEGES IN RESPECT TO ANALYSES.

MANURES, FEEDING-STUFFS, SOILS, AND AGRICULTURAL PRODUCTS.

The fees for analyses made for members of the Society shall, until further notice, be as follows:—

The determination of one ingredient in a single sample of a *manure* or of a *feeding stuff*, ... 5s.

The determination of two or more ingredients in a single sample of a *manure* or of a *feeding-stuff*, ... 10s.

For example—

Linseed and other cakes, for oil or for albuminoids, .	5s.
Feeding-meals, ground cereals, for oil or for albuminoids, .	
Bone-meals, for nitrogen or for phosphate, . .	
Compound manures, for nitrogen or for soluble phosphates, or for insoluble phosphates or for potash, . .	
Superphosphate, for soluble phosphate or for insoluble phosphate, ...	
Thomas-phosphate powder, for citric soluble phosphate or for total phosphate, ...	
Linseed and other cakes, for oil and albuminoids, &c., .	10s.
Feeding-meals, ground cereals, for oil, albuminoids, &c., .	
Bone-meals, for nitrogen, phosphate, &c , ...	
Compound manures, for nitrogen, soluble phosphates, insoluble phosphates, and potash, ...	
Superphosphate, for soluble phosphate and insoluble phosphate, ...	
Thomas-phosphate powder, for citric soluble phosphate and total phosphate, ...	

	£	s.	d.
Limestone, giving the percentage of lime, ...	£0	5	0
Limestone, complete analysis, ...	1	0	0
Lime, including ground lime, percentage of alkaline lime,	0	5	0
" " " complete analysis, . .	1	0	0
Analysis of soil, to determine fertility and recommendation of manurial treatment, ...	1	10	0
Complete analysis of soil, ...	2	10	0
Analysis of agricultural products—hay, grain, ensilage, roots, &c., ...	1	0	0

These charges apply only to analyses made for agricultural purposes, and for the sole and private use of members of the Highland and Agricultural Society who are not engaged in the manufacture or sale of the substances analysed.

Valuations of manures, according to the Society's scale of units, will be supplied if requested.

DAIRY PRODUCE.

Milk, full analysis,	£0 10 0
" solids and fat,	0 5 0
" fat only,	0 2 6
Butter, full analysis,	0 10 0
" partial analysis (water and fat),	0 5 0
Cheese,	0 10 0

WATER.

Analysis of water [1] to determine purity and fitness for domestic use (the Committee reserve power to refuse from one member more than two samples annually at the reduced fee)................at the reduced fee of	1 0 0

MISCELLANEOUS.

Search for poisons in food or viscera,	2 0 0
Sulphate of copper, percentage of copper and purity,	0 5 0
" " complete analysis,	0 10 0
Arsenic, carbolic acid and tar acids, and other poisons used in making sheep dips, insecticides, &c.,	5s. to £1

Samples should be sent (carriage paid) to Dr J. F. Tocher, Crown Mansions, 41½ Union Street, Aberdeen.

Note to Members sending Samples for Analysis.

The Directors are anxious to take any steps in their power to expose the vendors of inferior fertilisers and feeding-stuffs, and the members can give them assistance in this by supplying to the chemist, when sending samples for analyses, information as to the guarantee, if any, on which the goods were sold, and also as to the price charged.

INSTRUCTIONS FOR SELECTING SAMPLES FOR ANALYSIS.

MANURES.

Any method of sampling mutually agreed upon between buyer and seller may be adopted, but the following method is recommended as a very complete and satisfactory one: Four or more bags should be selected for sampling. Each bag is to be emptied out separately on a clean floor, worked through with the spade, and one spadeful taken out and set aside. The four or more spadefuls thus set aside are to be mixed together unlti a uniform mixture is obtained. Of this mixture one spadeful is to be taken, spread on paper, and still more thoroughly mixed, any lumps which it may contain being broken down with the hand. Of this mixture two samples of about half a pound each should be taken by the purchaser or his agent, in the presence of the seller or his agent or two witnesses (due notice having been given to the seller of the time and place of sampling), and these samples should be taken as quickly as possible, and put into bottles or tin cases to prevent loss of moisture, and having been labelled, should be sealed by the samplers—one or more samples to be retained by the purchaser, and one to be sent to the chemist for analysis.

[1] Cases containing bottles for water samples and instructions for sampling are sent from the laboratory on application.

FEEDING-STUFFS.

Samples of feeding-stuffs which are in the form of meal may be taken in a similar manner.

Samples of cake should be taken by selecting four or more cakes from the bulk. These should be nutted to a size not larger than walnuts. The nutted cake should then be thoroughly mixed and samples of not less than one pound each taken from it. The samples should be put into bottles or tins, sealed up, and labelled. One sample should be sent to the analyst, and one or more duplicates retained by the purchaser.

SOILS.

Dig a little trench about two feet deep, exposing the soil and subsoil. Cut from the side of this trench vertical scrapings of the soil down to the top of the subsoil. Catch these on a clean board, and collect in this manner two pounds of soil taken from the whole surface of the section. Similar scrapings of subsoil immediately below should be taken and preserved separately. Five or six similarly drawn samples at least should be taken from different parts of the field, and kept separate while being sent to the chemist, that he may examine them individually before mixing in the laboratory.

VEGETABLE PRODUCTS.

Turnips, &c. at least 50 bulbs carefully selected as of fair average growth.

Hay, straw, ensilage, &c., should be sampled from a thin section cut across the whole stack or silo, and carefully mixed ; above 2 lb. weight is required for analysis.

Grain should be sampled like manures.

DAIRY PRODUCE.

Milk.—Samples of milk from individual cows should be taken direct from the milk-pail after complete milking. Average samples from a number of cows should be taken immediately after milking. Specify whether the sample is morning or evening milk, or a mixture of these. Samples to be tested for adulteration should not be drawn from the bottom or taken from the top of standing milk, but they should be ladled from the vessel after the milk has been thoroughly mixed. Samples of milk should be sent immediately to the analyst.

For most purposes a half-pint bottle of milk is a large enough sample.

Butter and Cheese.—About quarter-pound samples are required.

WATERS.

When the water is from a well, it should be pumped for some minutes before taking the sample.

If the well has been standing unused for a long time, it should be pumped for some hours, so that the water may be renewed as far as possible.

If the well has been newly dug or cleaned out, it should be pumped as dry as possible, daily, for a week before taking the sample.

Water from cisterns, tanks, ponds, &c., should be sampled by immersing the bottle entirely under the water, and holding it, neck upwards, some inches below the surface. *Water from the surface should not be allowed to enter the bottle.*

Spring or stream water should not be sampled in very wet weather, but when the water is in ordinary condition. Such waters should be sampled by immersing the bottle, if possible; but if not deep enough for that purpose, a perfectly clean cup should be used for transferring the water to the bottle.

When the bottle has been filled the stopper should be rinsed in the water before replacing it.

Interference with or disturbance of wells or springs, or the ground in their immediate vicinity, must be carefully avoided during sampling, and for at least twenty-four hours before it.

After a sample has been taken, it should be sent to the laboratory as speedily as possible.

A description of the source and circumstances of the water should accompany the sample, as the interpretation of the analytical results depends to some extent on a knowledge of such particulars.

N.B.—Stone jars and old wine bottles are unsuitable for conveying samples. Winchester quarts chemically cleaned should be obtained from the laboratory, Crown Mansions, 41½ Union Street, Aberdeen.

LOCAL ANALYTICAL ASSOCIATIONS.

With the view of encouraging, as well as regulating the conduct of, Local Analytical Associations, the Society, from 1881 to 1893, contributed from its funds towards their expenses a sum not exceeding £250 annually. In view of the passing of the Fertilisers and Feeding Stuffs Act, 1893, it was decided, at a meeting of the Directors on the 6th of December 1893, to discontinue that grant after the 1st of March 1894.

COMPOSITION AND CHARACTERISTICS OF MANURES AND FEEDING-STUFFS.

(*See 'Transactions,' Fifth Series, vol. xi.* 1899.)

FORMS OF GUARANTEE

Guarantee of Manure.

I guarantee that the manure called....................and sold by me to ....contains a minimum of—

Soluble phosphoric acid	=Phosphate of lime dissolved	per cent.
Insoluble phosphoric acid	=Phosphate of lime undissolved.........	per cent.
Potash salts . .	=Potash (K_2O)	per cent.
Total nitrogen . .	=Ammonia	per cent.

Signature of seller.......................

Date.... 19

Guarantee of Feeding-Stuff.

I guarantee that the feeding-stuff called...............and sold by me to ....contains a minimum of—

. per cent albuminoids.
. per cent oil.
. per cent carbohydrates.

Signature of seller.

Date..................19...

UNITS TO BE USED IN DETERMINING THE MARKET PRICE OF FERTILISERS.[1]

Terms—CASH, including Bags gross weight—not including Carriage.

For the sake of continuity, the Schedule of Unit Values based on prices of 7th February 1917 is issued as usual. Owing to abnormal conditions, the figures given should not be used this year for the purposes to which they have been put in the past.

For Season 1917.

[The undernoted prices are those given in the Return of Market Prices issued by the Board of Agriculture for Scotland for the week ending Wednesday, 7th February 1917, except in the case of those fertilisers marked with an asterisk (*).]

Items to be valued	Peruvian (Riddled) Phosphatic	Bone Meal.	Steamed Bone Flour	Superphosphates. *28% Sol	Superphosphates. *30% Sol	Superphosphates. *35% Sol	Superphosphates. *38% Sol
	P unit	P unit	P unit	P unit	P unit	P unit	P unit
Phosphates dissolved .				3/7¼	3/6¾	3/6¼	3/6
" undissolved		4/1	3/1				
Potash							
Nitrogen . . .		15/6	15/6				
Prices per ton . .		255/	200/	100/11	106/11	123/6	133/-

FERTILISERS

At Leith and Glasgow	Guarantee	Price per Ton.	Unit
	Per cent	£ s d	
*Sulphate of ammonia .	20 Nitrogen	15 10 0 (at the works)	15/6
Nitrate of soda, 95 per cent .	15 5 "	21 0 0	27/1¼
Muriate of potash, 80 per cent . .	50 Potash		
Kainit (unpulverised)	12 4 "		
Potash salts . .	30 "		
Basic slag (Thomas-phosphate powder	T.P. C.S.P.†		
	22 17		
	28 22	3 12 6	3/[illegible]
	– *32	4 6 0	
	– *34	4 17 6	
*Ground mineral phosphate .	60 Total phosphate	6 0 0	2/
Nitrate of lime			
Ground Mineral Phosphate (Ephos)	63 Total phosphate	9 10 0	3/-

† T.P. Total phosphate, C.S.P. = Citric soluble phosphate.

[1] Instructions regarding units and the valuation of fertilisers are given on p. 40.

FEEDING-STUFFS.

	Average Analyses.			Price per ton at Glasgow.	Price per ton at Leith.
	Album.	Oil.	Carbo-hydrates.		
	Per cent	Per cent.	Per cent.	£ s. d.	£ s. d.
Linseed-cake (home)	29	9	34	18 15 0	18 17 6
" (foreign) . . .	30	8	34	18 10 0	18 10 0
Decorticated cotton-cake . . .	40	9	24	..	18 15 0
Undecorticated " (Egyptian)	22	5½	34	15 15 0	16 5 0
" " (Bombay) .	19	4½	36	..	15 15 0
Soya-bean cake	40	6	30	..	..
Cocoanut cake	21	10	40	..	..
Palm-nut kernel cake . . .	18	6	45	..	13 10 0†
Ground-nut cake (decorticated) .	44	9	23	18 0 0	..
Soya-bean meal		..	..	..	..
Bean meal	25	1½	48	18 5 0	..
Maize meal	10½	5	70	17 10 0	17 17 6
Rice meal	12	12	50	16 10 0	..
Locust-bean meal .	6	1½	70	.	..
Wheat bran (medium) . . .	15	4	56	15 0 0	14 0 0
" (broad)	15	4	54	15 15 0	15 0 0
Wheat middlings	15	3½	62	17 0 0	15 10 0
Wheat sharps *	15	4½	57	15 5 0	14 10 0
Dried distillery grains . . .	20	8	45	13 15 0	14 10 0
Brewer's grains dried * . .	20	6	45	13 12 6	14 5 0
Indian corn (maize)	10½	5	70	17 0 0	17 2 6
Oats	12	6	55	16 10 0	16 0 0
Feeding treacle	10	0	60	16 15 0	16 0 0
Crushed linseed	23	35	23	..	27 0 0
Fish meal	54	2	0	14 0 0	15 0 0

* Bags included. † Carriage paid on 2-ton lots to any station.

CLASSIFICATION OF FERTILISERS.

Peruvian guano . .	Guanos with over 4 per cent of nitrogen are to be considered as nitrogenous. Those with less than this percentage are to be classed as phosphatic guano.
Bone-meal . . .	Genuine bone-meal contains from 48 per cent to 55 per cent phosphates, and from 3¾ per cent to 4½ per cent nitrogen. If phosphates are low, nitrogen will be high, and conversely.
Steamed bone-flour .	Ground to flour, and containing about 60 to 70 per cent phosphates and about 1 to 1½ per cent nitrogen.
Dissolved bones . .	Must be pure—*i.e.*, containing nothing but bones and sulphuric acid.
Mixtures and compound manures	No recommendation is made as to the valuation of mixtures and compound manures for this year.
Basic slag (Thomas-phosphate powder)	Citric soluble phosphate means phosphate soluble in citric acid in accordance with the official method of Board of Agriculture. Fineness of grinding is of importance. The coarsest kind used should be so finely ground that at least 80 per cent passes through a wire sieve of about 9600 holes per sq. inch.

INSTRUCTIONS FOR VALUING FERTILISERS.

The unit used for the valuation of fertilisers is the hundredth part of a ton, and as the analyses of fertilisers are expressed in parts per hundred, the percentage of any ingredient of a fertiliser when multiplied by the price of the unit of that ingredient represents the value of the quantity of it contained in a ton.

Note.—The units have reference solely to the MARKET PRICE of Fertilisers at 7th February 1917, and not to their AGRICULTURAL VALUES.

BOTANICAL DEPARTMENT

Consulting Botanist to the Society—A. N. M'ALPINE,
6 Blythswood Square, Glasgow.

The Society have fixed the following rates of charge for the examination of plants and seeds for the *bona fide* and individual use and information of members of the Society (not being seedsmen), who are particularly requested, when applying to the Consulting Botanist, to mention the kind of examination they require, and to quote its number in the subjoined schedule. The charge for examination must be paid at the time of application, and the carriage of all parcels must be prepaid.

Scale of Charges.

1. A report on the purity, amount, and nature of foreign materials, and the germinating power of a sample of seed, 1s.
2. Determination of the species of any weed or other plant, or of any vegetable parasite, with a report on its habits and the means for its extermination or prevention, 1s.
3. Report on any disease affecting farm crops, 1s.
4. Determination of the species of any natural grass or fodder plant, with a report on its habits and pasture or feeding value, 1s.

The Consulting Botanist's Reports are furnished to enable members—purchasers of seeds and corn for agricultural or horticultural purposes—to test the value of what they buy, and are not to be used or made available for advertising or trade purposes by seedsmen or otherwise.

Purchase of Seeds.

The purchaser should obtain from the vendor, by invoice or other writing, the proper designation of the seed he buys, with a guarantee of the percentage of purity and germination, and of its freedom from ergot, and in the case of clover, from the seeds of dodder or broom-rape.

It is strongly recommended that the purchase of *prepared mixtures* of seeds should be avoided. The different seeds should be purchased separately and mixed by the farmer: mixtures cannot be tested for germination.

ing of Seeds.

The utmost care should be taken to secure a fair and honest sample. This should be drawn from the bulk delivered to the purchaser, and not from the sample sent by the vendor.

When legal evidence is required, the sample should be taken from the bulk, and placed in a sealed bag in the presence of a witness. Care should be taken that the sample and bulk be not tampered with after delivery, or mixed or brought in contact with any other sample or bulk.

At least one ounce of grass and other small seeds should be sent, and two ounces of cereals and the larger seeds. When the bulk is obviously impure the sample should be at least double the amount specified. Grass seeds should be sent at least four weeks, and seeds of clover and cereals two weeks, before they are to be used.

The exact name under which the sample has been sold and purchased should accompany it.

Reporting the Results.

The Report will be made on a schedule in which the nature and amount of impurities will be stated, and the number of days each sample has been under test, with the percentage of the seeds which have germinated.

"Hard" clover seeds, though not germinating within the time stated, will be considered good seeds, and their percentage separately stated.

The impurities in the sample, including the chaff of the species tested, will be specified in the schedule, and only the percentage of the pure seed of that species will be reported upon; but the REAL VALUE of the sample will be stated. The Real Value is the combined percentages of purity and germination, and is obtained by multiplying these percentages and dividing by 100: thus in a sample of Meadow Fescue having 88 per cent purity and 95 per cent germination, 88 multiplied by 95 gives 8360, and this divided by 100 gives 83·6, the Real Value.

Selecting Specimens of Plants.

The whole plant should be taken up and the earth shaken from the roots. If possible the plants must be in flower or fruit. They should be packed in a light box, or in a firm paper parcel.

Specimens of diseased plants or of parasites should be forwarded as fresh as possible. They should be placed in a bottle, or packed in tinfoil or oil-silk.

All specimens should be accompanied with a letter specifying the nature of the information required, and stating any local circumstances (soil, situation, &c.) which, in the opinion of the sender, would be likely to throw light on the inquiry.

Parcels or letters containing seeds or plants for examination (carriage or postage paid) must be addressed to Professor M'Alpine, Botanical Laboratory, 6 Blythswood Square, Glasgow.

ENTOMOLOGICAL DEPARTMENT

Consulting Entomologist to the Society—Dr R. Stewart MacDougall, 9 Dryden Place, Edinburgh.

Arrangements have been made with Mr R. Stewart MacDougall, M.A., D.Sc., Edinburgh, to advise members of the Society regarding insects or allied animals which, in any stage of their development, infest—

(*a*) Farm crops.
(*b*) Stored grain.
(*c*) Garden and greenhouse plants.
(*d*) Fruit and fruit trees.
(*e*) Forest trees and stored timber.
(*f*) Live stock (including poultry).

Members consulting Dr MacDougall will please forward with their queries examples of the injured plants, or the injured parts of plants, &c., as well as specimens of the insects or other animals believed to be the cause of the injury.

Specimens should be sent in tin or wooden boxes, or in quills, to prevent injury in transmission.

Address letters and parcels (carriage or postage paid) to Dr R. Stewart MacDougall, 9 Dryden Place, Edinburgh.

The Directors have fixed the fee payable by members to Dr MacDougall at 1s. for each case upon which he is consulted : this fee must be sent to him along with the application for information.

PREMIUMS

GENERAL REGULATIONS FOR COMPETITORS.

1. It is to be distinctly understood that the Society is not responsible for the views, statements, or opinions of any of the writers whose papers are published in the 'Transactions.'

2. All reports must be legibly written, and on one side of the paper only; they must specify the number and subject of the Premium for which they are in competition; they must bear a distinguishing motto, and be accompanied by a sealed letter, similarly marked, containing the name and address of the reporter—initials must not be used.

3. No sealed letter, unless belonging to a report found entitled to the Premium offered, or a portion of it, will be opened without the author's consent.

4. Reports for which a Premium, or a portion of a Premium, has been awarded, become the property of the Society, and cannot be published in whole or in part, nor circulated in any manner, without the consent of the Directors. All other papers will be returned to the authors if applied for within twelve months.

5. The Society is not bound to award the whole or any part of a Premium.

6. All reports must be of a practical character, containing the results of the writer's own observation or experiment, and the special conditions attached to each Premium must be strictly fulfilled. General essays, and papers compiled from books, will not be rewarded or accepted. Weights and measurements must be indicated by the imperial standards.

7. The Directors, before or after awarding a Premium, shall have power to require the writer of any report to verify the statements made in it.

8. The decisions of the Board of Directors are final and conclusive as to all matters relating to Premiums, whether for Reports or at General or District Shows; and it shall not be competent to raise any question or appeal touching such decisions before any other tribunal.

9. The Directors will welcome papers from any Contributor on any suitable subject, whether included in the Premium List or not; and if the topic and the treatment of it are both approved, the writer may be remunerated and his paper published.

CLASS I.

REPORTS.

SECTION 1.—THE SCIENCE AND PRACTICE OF AGRICULTURE.

FOR APPROVED REPORTS.

1. On any useful practice in Rural Economy adopted in other countries, and susceptible of being introduced with advantage into Scotland—The Gold Medal. To be lodged by 1st November in any year.

The purpose chiefly contemplated by the offer of this premium is to induce travellers to notice and record such particular practices as may seem calculated to benefit Scotland. The Report to be founded on personal observation.

2. Approved Reports on other suitable subjects. To be lodged by 1st November in any year.

SECTION 2.—ESTATE IMPROVEMENTS.

FOR APPROVED REPORTS.

1. By the Proprietor in Scotland who shall have executed the most judicious, successful, and extensive Improvement—The Gold Medal, or Ten Sovereigns. To be lodged by 1st November in any year.

Should the successful Report be written for the Proprietor by his resident factor or farm manager, a Minor Gold Medal will be awarded to the writer in addition to the Gold Medal to the Proprietor.

The merits of the Report will not be determined so much by the mere extent of the improvements, as by their character and relation to the size of the property. The improvements may comprise reclaiming, draining, enclosing, planting, road-making, building, and all other operations proper to landed estates. The period within which the operations may have been conducted is not limited, except that it must not exceed the term of the Reporter's proprietorship.

2. By the Proprietor or Tenant in Scotland who shall have reclaimed within the ten preceding years not less than forty acres of Waste Land—The Gold Medal, or Ten Sovereigns. To be lodged by 1st November in any year.

3. By the Tenant in Scotland who shall have reclaimed within the ten preceding years not less than twenty acres of Waste Land —The Gold Medal, or Ten Sovereigns. To be lodged by 1st November in any year.

4. By the Tenant in Scotland who shall have reclaimed not less than ten acres within a similar period—The Medium Gold Medal, or Five Sovereigns. To be lodged by 1st November in any year.

The Reports in competition for Nos. 2, 3, and 4 may comprehend such general observations on the improvement of waste lands as the writer's

experience may lead him to make, but must refer especially to the lands reclaimed—to the nature of the soil—the previous state and probable value of the subject—the obstacles opposed to its improvement—the details of the various operations—the mode of cultivation adopted—and the produce and value of the crops produced. As the required extent cannot be made up of different patches of land, the improvement must have relation to one subject; it must be of profitable character, and a rotation of crops must have been concluded before the date of the Report. *A detailed statement of the expenditure and return* and a certified measurement of the ground are requisite.

5. By the Proprietor or Tenant in Scotland who shall have improved within the ten preceding years the Pasturage of not less than thirty acres, by means of top-dressing, draining, or otherwise, without tillage, in situations where tillage may be inexpedient—The Gold Medal, or Ten Sovereigns. To be lodged by 1st November in any year.

6. By the Tenant in Scotland who shall have improved not less than ten acres within a similar period—The Minor Gold Medal. To be lodged by 1st November in any year.

Reports in competition for Nos. 5 and 6 must state the particular mode of management adopted, the substances applied, the elevation and nature of the soil, its previous natural products, and the changes produced.

SECTION 3.—HIGHLAND INDUSTRIES AND FISHERIES.

FOR APPROVED REPORTS.

1. The best mode of treating native Wool; cleaning, carding, dyeing, spinning, knitting, and weaving by hand in the Highlands and Islands of Scotland—Five Sovereigns. To be lodged by 1st November in any year.

SECTION 4.—MACHINERY.

FOR APPROVED REPORTS.

To be lodged by 1st November in any year.

SECTION 5.—FORESTRY DEPARTMENT.

FOR APPROVED REPORTS.

1. On Plantations of not less than eight years' standing formed on deep peat-bog—The Medium Gold Medal, or Five Sovereigns. To be lodged by 1st November in any year.

The premium is strictly applicable to deep peat or flow moss; the condition of the moss previous to planting, as well as at the date of the Report, should, if possible, be stated.

The Report must describe the mode and extent of the drainage, and the effect it has had in subsiding the moss—the trenching, levelling, or other preliminary operations that may have been performed on the surface—the mode of planting—kinds, sizes, and number of trees planted per acre—and their relative progress and value, as compared with plantations of a similar age and description grown on other soils in the vicinity.

CLASS II.

DISTRICT COMPETITIONS.

REGULATIONS 1917.

Grants in aid of DISTRICT COMPETITIONS *for* 1918 *must be applied for before* 1*st November* 1917, *on Forms to be obtained from the Secretary.*

When a Money Grant has expired, the District cannot apply again for another Money Grant for four years.

SECTION I.—GRANTS TO DISTRICT SOCIETIES FOR HORSES, CATTLE, SHEEP, AND PIGS.

1. CLASS OF STOCK—LIMIT OF GRANTS, £340.—The Highland and Agricultural Society will make Grants to District Societies for prizes for *Breeding Animals* of any of the following Classes of Stock, viz. :—

Cattle.

Shorthorn.
Aberdeen-Angus.
Galloway.
Highland.
Ayrshire.
Holstein-Friesian.
Jersey.

Horses.

Draught Horses.
Hunters.
Hackneys.
Ponies.
Shetland Ponies.

Sheep.

Blackface.
Cheviot.
Border Leicester.
Half-Bred.
Shropshire.
Oxford-Down.
Suffolk.
Wensleydale.

Pigs.

Any Pure Breed.

Cross-bred [1] animals are not eligible. The Prizes must be confined to *Breeding* Animals; "bullocks," "geldings," "wethers," and "hog pigs" are excluded.

2. All Competitions must be at the instance of a local Society. A Committee of Management shall be appointed, and the Convener of the Committee must be a Member of the Highland and Agricultural Society.

3. GRANT TO DISTRICT, £12.—The portion of the Grant to any one District Society shall not exceed the sum of £12 in any one year.

4. ALLOCATION OF GRANT.—The Grant from the Highland and Agricultural Society is not to be applied as a Grant in aid of the Premiums offered by the Local Society, but must be offered in the form of separate Prizes for the Animals chosen; *and the Prizes must be announced in the Premium List and Catalogue of the Show as "given by the Highland and Agricultural Society."*

5. CONTINUANCE OF GRANT THREE YEARS.—The Money Grant shall continue for three alternate years, provided always that the District Society shall, in the two intermediate years, continue the competition by offering Premiums for the same class of Stock as that selected in each previous year to compete for the Highland and Agricultural Society's Prizes. If no competition takes place for two years the Grant expires.

[1] *Exceptions to this rule may, however, be authorised by the Board of Directors, on application. The Directors are prepared to consider applications from local Societies which desire to use their grants, or part thereof, as prizes for cross-bred calves and one-year-old cross-bred cattle.*

6. When it is agreed to hold the General Show of the Society in any district, no provincial show shall be held in that district in the months of June, July, or August.

7. MEDALS IN INTERMEDIATE YEARS.—In the two alternate years the Highland and Agricultural Society will place three Silver Medals at the disposal of the District Societies, for the same classes of Stock as those for which the Money Premiums are offered, provided that not less than three lots are exhibited in the same class.

8. RULES OF COMPETITION.—The Rules of Competition for the Premiums, the Funds for which are derived from Grants of the Highland and Agricultural Society, shall be such as are generally enforced by the Society receiving the Grant for Premiums offered by itself.

9. AREA AND PARISHES—FIVE PARISHES.—When making application for Grants from the Highland and Agricultural Society, the District Society must delineate the area and the number of parishes comprised in the district, and, *except in special cases*, no District Society shall be entitled to a Grant whose show is not open to at least *five* Parishes.

10. REPORTS.—Blank Forms for Reports will be furnished to the Secretaries of the different District Societies. Both in the years when the Grant is offered and in the two intermediate years, detailed reports of the competition must be given on these Forms and lodged with the Secretary of the Highland and Agricultural Society as soon as possible after the Show, and in no case later than 1st November. These reports are subject to the approval of the Directors of the Highland and Agricultural Society, against whose decision there shall be no appeal. All Reports must be signed and certified as marked in the Form.

11. GRANTS—WHEN PAID.—The Grants made to District Societies will be paid in December after the Reports of the awards of the prizes have been received and found to be in order and passed by the Board of Directors, the Money Grants being paid to the Secretaries of the Local Societies and the Medals sent direct to the winners. *The Secretary of the District Society must not on any condition whatever pay any premium offered by the Highland and Agricultural Society until he has been informed that the awards are in order and has received the Grant from the Highland and Agricultural Society.*

12. RENEWAL OF APPLICATION.—No application for renewal of a Money Grant to a District Society will be entertained until the expiration of *four years* from the termination of the last Grant.

13. DISPOSAL OF APPLICATIONS.—In disposing of applications for District Grants, the Directors of the Highland and Agricultural Society shall keep in view the length of interval that has elapsed since the expiration of the last Grant, giving priority to those District Societies which have been longest off the list.

DISTRICTS.

Final Year

1. NITHSDALE AGRICULTURAL SOCIETY.—*Convener*, Charles W. Ralston, Dabton, Thornhill; *Secretary*, David Paterson, Solicitor, Thornhill. Granted 1909. (In abeyance in 1910 on account of the Dumfries Show.) (In abeyance 1914, 1915, and 1916—no Show held.)
2. WESTER ROSS FARMERS' CLUB.—*Convener*, William Stirling, Fairburn, Muir of Ord; *Secretary*, James Cumming, County Buildings, Dingwall. Granted 1909. (In abeyance in 1911 on account of the Inverness Show.) (In abeyance 1914, 1915, and 1916—no Show held.)
3. STRATHSPEY FARMERS' CLUB.—*Convener*, J. Grant Smith, Strathspey Estate Office, Grantown-on-Spey; *Secretary*, Gilbert Brown,

Grantown-on-Spey. Granted 1909. (In abeyance in 1911 on account of the Inverness Show.) (In abeyance 1914, 1915, and 1916 —no Show held.)

4. CLACKMANNANSHIRE UNION AGRICULTURAL SOCIETY. — *Convener*, Donald A. Kinross, Hillend, Clackmannan; *Secretary*, Alexander L. Roxburgh, Solicitor, Alloa. Granted 1911. (In abeyance 1915 and 1916—no Show held.)
5. STRATHENDRICK AGRICULTURAL SOCIETY.—*Convener and Secretary*, W. Watson Murray, Catter House, Drymen. Granted 1911. (In abeyance 1915 and 1916—no Show held.)
6. DOUNE AGRICULTURAL ASSOCIATION. — *Convener*, John Scrimgeour, Doune Lodge, Doune; *Secretary*, William Gray, Doune. Granted 1912. (In abeyance 1916—no Show held.)

2nd Year.

7. ARGYLL CATTLE SHOW SOCIETY.—*Convener*, Captain John Campbell of Kilberry; *Secretary*, James M'Dougall, South Cliff, Tarbert, Lochfyne. Granted 1910. (In abeyance in 1910—unable to hold a show. In abeyance in 1913 on account of the Paisley Show.) (In abeyance 1914, 1915, and 1916—no Show held.)
8. CASTLE DOUGLAS AGRICULTURAL SOCIETY. — *Convener*, Charles A. Phillips of Dildawn, Castle Douglas; *Secretary*, Patrick Gifford, 118 King Street, Castle Douglas. Granted 1912. (In abeyance 1912, 1915, and 1916—no Show held.)
9. KILLEARN AGRICULTURAL SOCIETY. — *Convener*, C. E. Horsburgh, Blairquhosh, Blanefield; *Secretary*, Robert N. Morrison, Dumgoyach, Blanefield, Stirlingshire. Granted 1914. (In abeyance 1916—no Show held.)
10. CROMAR, UPPER DEE, AND DONSIDE AGRICULTURAL SOCIETY.—*Convener*, William H. Coltman of Tillypoonie, Tarland; *Secretary*, William Anderson, Home Farm, Hopewell, Tarland. Granted 1915.
11. ARRAN FARMERS' SOCIETY.—*Convener*, James J. Morton, Machrie, Arran; *Secretary*, James Bone, jun., Glenkiln, Lamlash. Granted 1915.
12. CARRICK FARMERS' SOCIETY.—*Convener*, Alexander Cross of Knockdon, Maybole; *Secretaries*, J. & J. M. Gibson, Royal Bank, Maybole. Granted 1915.

1st Year.

13. EASTER ROSS FARMERS' CLUB.—*Convener*, James G. Young, Cadboll, Fearn; *Secretary*, George D. Gill, Commercial Bank Buildings, Tain. Granted 1914. (In abeyance 1914, 1915, and 1916—no Show held.)
14. FORTH AGRICULTURAL SOCIETY.—*Convener*, David M'Culloch, The Inn, Forth; *Secretary*, George Muir, East Crofthill, Carnwath. Granted 1915. (In abeyance 1915 and 1916—no Show held.)
15. MOUNT BLAIR AGRICULTURAL SOCIETY. — *Convener*, James M'L. Marshall, Bleaton Hallet, Blairgowrie; *Secretaries*, J. Stewart and J. Mitchell, Bleaton, Blairgowrie. Granted 1915. (In abeyance 1915 and 1916—no Show held.)
16. BUCHLYVIE AND GARTMORE AGRICULTURAL SOCIETY.—*Convener*, John Dempster, Estates Office, Gartmore; *Secretary*, James Monach, Craignorton, Buchlyvie. Granted 1916. (In abeyance 1916—no Show held.)
17. DUMBARTONSHIRE AGRICULTURAL SOCIETY.—*Convener*, A. C. Lawrie, Muirhouses, Duntocher; *Secretary*, William Davie, 253 Main Street, Alexandria. Granted 1916. (In abeyance 1916—no Show held.)

18. Poltalloch Farming Society.—*Convener*, Colonel Malcolm, C.B., of Poltalloch, Kilmartin; *Secretary*, J. G. Mathieson, Poltalloch Estate Office, Kilmartin. Granted 1917.

(In Intermediate Year—8 Silver Medals.)

19. Moffat and Upper Annandale Agricultural and Horticultural Society.—*Convener*, Basil H. Hill, Archbank, Moffat; *Secretaries*, James Johnstone, Solicitor, Moffat, and John Young, High Street, Moffat. Granted 1911. (In abeyance 1914, 1915, and 1916—no Show held.)
20. Glenkens Agricultural Society. — *Convener*, J. M. Kennedy, Knocknalling, Dalry; *Secretary*, James M'Gill, High Street, New Galloway. Granted 1911. (In abeyance 1914, 1915, and 1916—no Show held.)
21. Strathbogie Farmer Club. — *Convener*, William Wilson, Coynachie, Gartly; *Secretary*, William M. Morrison, Cairnie, Huntly. Granted 1912. (In abeyance 1915 and 1916—no Show held.)
22. Islay, Jura, and Colonsay Agricultural Association.—*Convener*, James Forbes, Eallabus, Bridgend, Islay; *Secretary*, Robert Cullen, Bridgend, Islay. Granted 1912. (In abeyance in 1913 on account of the Paisley Show.) (In abeyance 1914, 1915, and 1916—no Show held.)
23. Formartine Agricultural Association.—*Convener*, George Walker, Tillygreig, Udny Station; *Secretary*, James Skinner, Mosstown Cottage, Logiereive, Udny. Granted 1913. (In abeyance 1916—no Show held.)
24. Liddesdale Agricultural Society.—*Convener*, David Ballantyne, Shaws, Newcastleton; *Secretary*, Robert Brown, British Linen Bank, Newcastleton. Granted 1913. (In abeyance in 1914 on account of the Hawick Show.) (1915 and 1916—no Show held.)
25. Yarrow and Ettrick Pastoral.—*Convener*, Walter Barrie, Sundhope, Selkirk; *Joint-Secretaries*, Walter Barrie and John Johnstone, Sundhope, Selkirk. Granted 1913. (In abeyance in 1914 on account of the Hawick Show.) (1915 and 1916—no Show held.)
26. Ardoch Agricultural Society.—*Convener*, Robert Miller, Overardoch, Braco; *Secretary*, John Maxton, Rhynd, Braco, Perthshire. Granted 1914. (In abeyance 1915 and 1916—no Show held.)
27. Ythanside Farmers' Club.—*Convener*, William Kemp, Aldie, Port Erroll; *Secretary*, John Mark, Bank Agent, Ellon. Granted 1914.
28. United Banffshire Agricultural Society.—*Convener*, Alexander Murray, Old Manse, Boyndie, Banff; *Secretary*, John A. Badenoch, 27 High Street, Banff. Granted 1915. (In abeyance 1916—no Show held.)
29. Morayshire Farmer Club.—*Convener*, C. J. Johnston of Lesmurdie, Elgin; *Secretary*, W. Rose Black, Solicitor, Elgin. Granted 1915. (In abeyance 1916—no Show held.)
30. Lanarkshire Farmers' Society.—*Convener*, ; *Secretary*, James Cassels, Union Bank of Scotland, Hamilton. Granted 1915. (In abeyance 1916—no Show held.)
31. Inverness-shire Farmers' Society.—*Convener*, P. B. Macintyre, Findon, Conon Bridge; *Secretary*, Fred. J. Baxter, Royal Bank Buildings, Inverness. Granted 1916.
32. Upper Ward of Lanarkshire Agricultural Society.—*Convener*, David M'Culloch, Forth; *Secretary*, William Shaw, Royal Bank House, Lanark. Granted 1916.

(In Abeyance 1917.)

33. United East Lothian Agricultural Society.—*Convener*, Thomas Elder of Stevenson Mains, Haddington; *Secretary*, John Stirling, Solicitor, Haddington. Granted 1911. (In abeyance in 1915, 1916, and 1917 on account of the Edinburgh Show.)
34. Dalkeith Agricultural Society.—*Convener*, Phipps O. Turnbull, Smeaton, Dalkeith; *Secretary*, James W. Speedy, Braeside, Liberton. Granted 1916. (In abeyance in 1916—no Show held.) (In abeyance in 1917 on account of the Edinburgh Show.)

In 1917.

Nos. 1, 2, 3, 4, 5, and 6 are in competition for the final year.
Nos. 7, 8, 9, 10, 11, and 12 are in competition for the second year.
Nos. 13, 14, 15, 16, 17, and 18 are in competition for the first year.
Nos. 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, and 32 are in intermediate year and compete for local Premiums. (See Rules 5 and 7.)
Nos. 33 and 34 are in abeyance on account of the Edinburgh Show.

Section 2.—GRANTS TO HORSE ASSOCIATIONS, &c., FOR STALLIONS FOR AGRICULTURAL PURPOSES.

1. The Highland and Agricultural Society will make Grants to Horse Associations and other Societies in different districts engaging Stallions for agricultural purposes. The total sum expended by the Highland and Agricultural Society in such Grants shall not exceed the sum of £210 in any one year.
2. The portion of the Grant to any one Association or Society shall not exceed the sum of £15 in any one year.
3. The Grant will be available only for Stallions which, for the year to which the Grant applies, are Registered in the Register of Certified Draught Stallions published by the Board of Agriculture. (For information regarding the Registration of Stallions, apply to the Secretary of the Board of Agriculture, 4 Whitehall Place, London, S.W.)
4. The Grant will continue for three years provided the Association receiving the Grant shall hire a Registered Stallion in the two intermediate years.
5. In the event of a Horse not being engaged in any one year while the provisions of the Grant are in force, the Grant made by the Highland and Agricultural Society will cease.
6. Rules 2 (Committee and Convener), 10 (Reports), 11 (Time of Payment), 12 (Renewal of Grant), and 13 (Disposal of Applications) applicable to Section 1, shall be applicable to this Section.

DISTRICTS.

Final Year.

1. Deeside Stock Improvement Society.—*Convener*, Sir Thomas Burnett of Leys, Bart., Crathes Castle; *Secretary*, John Cooper, Ley, Banchory. Granted 1913.
2. East of Fife Entire Horse Society.—*Convener*, John Rodger, Balgone, St Andrews; *Secretary*, Alexander Brown, Pitcorthie Mains, Kilconquhar. Granted 1913. (£15 not paid in 1913—Stallion not registered.)

2nd Year.

3. Buchlyvie and Vale of Menteith Horse-Breeding Society.—*Convener and Secretary*, John Drysdale, 5 St Andrew Square, Edinburgh. Granted 1915.
4. Carse and Dundee District Stallion Society.—*Convener*, J. W. Colville, Leoch, Auchterhouse; *Secretary*, William L. Thoms, Benvie, Invergowrie. Granted 1915.
5. Gigha Horse-Breeding Society.—*Convener*, W. J. Yorke Scarlett of Gigha, Argyllshire; *Secretary*, W. W. Philip, Estates Office, Gigha. Granted 1915.

1st Year.

6. South Deeside Stock Improvement Society.—*Convener*, Robert Milne, Wester Durris, Drumoak; *Secretary*, Alexander M'Rae, Kirkton Mills, Durris, Drumoak. Granted 1917.
7. Central Banffshire Farmers' Club.—*Convener*, John Macpherson, Mains of Mulben, Boharm; *Secretary*, George Donald, Ladyhill, Grange, Keith. Granted 1917.
8. Glenkens and District Horse-Breeding Society.—*Convener*, John Young, Brockloch, Dalbeattie; *Secretary*, Robert T. Scott, Drumhumphry, Corsock, Dalbeattie. Granted 1917.
9. Kilfinan and Cowal Entire Horse Society.—*Convener*, Robert M. Reid, Toward Point, Toward; *Secretary*, Neil Nicolson, Auchgayle Farm, Millhouse, Kyles of Bute. Granted 1917.
10. Kirriemuir District Agricultural Society.—*Convener*, John Duncan, Muirhouses, Kirriemuir; *Secretary*, J. A. Carnegie, Solicitor, Kirriemuir. Granted 1917.
11. Lauderdale and West of Berwickshire Agricultural Society.—*Convener and Secretary*, George L. Broomfield, Lauder. Granted 1917.
12. Morayshire Clydesdale Horse-Breeding Society.—*Convener*, James M'William, Garbity, Orton Station; *Secretary*, H.M.S. MacKay, Elgin. Granted 1917.
13. Orkney West Mainland Horse-Breeding Society.—*Convener*, William T. Wood, Aikerness, Evie, Orkney; *Secretary*, David M. Leask, Howan, Dounby, Orkney. Granted 1917.

Intermediate Year—Grant in Abeyance.

14. Cromar and Upper Deeside Stallion Society.—*Convener*, James Henry, Kinaldie, Dinnet; *Secretary*, William Anderson, Hopewell, Tarland. Granted 1914.
15. Cumbernauld, Kilsyth, and Kirkintilloch Clydesdale Horse Society.—*Convener*, Alexander Whitelaw, Gartshore, Kirkintilloch; *Secretary*, Alexander Park, 175 Hope Street, Glasgow. Granted 1914.
16. Upper Nithsdale Horse Society.—*Convener*, Charles W. Ralston, Dabton, Thornhill; *Secretary*, D. Paterson, Solicitor, Thornhill. Granted 1914.
17. Scone, Strathord, and Murthly Premium Horse Society.—*Convener*, John Chalmers, Westwood, Stanley; *Secretary*, James Stewart, Friarton, Perth. Granted 1914.
18. East Mainland Co-operative Horse-Breeding Society.—*Convener*, John Clouston, Graemeshall, Holm, Orkney; *Secretary*, Andrew Skea, Aikerskaill, Deerness Orkney. Granted 1916.

19. Inverness District Horse-Breeding Society.—*Convener*, Hugh M'Kintosh, Rosevalley, Croy; *Secretary*, William R. Ross, Milton of Culloden, Inverness. Granted 1916.
20. Kintyre Horse-Breeding Society.—*Convener*, John Gemmell, Campbeltown; *Secretary*, Hugh Baird, Ugadale Estate Office, Campbeltown. Granted 1916.

In 1917.

Nos. 1 and 2 are in competition for the final year.
Nos. 3, 4, and 5 are in competition for the second year.
Nos. 6, 7, 8, 9, 10, 11, 12, and 13 are in competition for the first year.
Nos. 14, 15, 16, 17, 18, 19, and 20 are in abeyance, and compete for local premiums. (See Rule 4.)

SPECIAL GRANTS.

Annual.

£40 to the Highland Home Industries Association.—*Secretary*, Miss Jessie D. C. Ross, Riverfield, Inverness. Granted 1895. (Did not hold a competition in 1899, 1900, 1908, 1914, 1915, or 1916.)

£20 to the Ayrshire Agricultural Association, to be competed for at the Dairy Produce Show at Kilmarnock.—*Convener*, James Middleton, Estate Office, Braehead, Kilmarnock; *Secretary*, John Howie, 58 Alloway Street, Ayr. Granted 1872. (No competition 1914, 1915, and 1916.)

The British Dairymaids' Association.—*Convener*, Mrs J. H. R. Turnbull, 7 W. Maitland Street, Edinburgh; *Secretary*, Miss A. H. Smith, 12 Grassmarket, Edinburgh. 1 Minor Gold Medal and 1 Medium Silver Medal for Champion Butter-making Competitions. Granted 1908. (In abeyance 1914, 1915, and 1916—no competition.)

In Alternate Years.—Grant in 1917.

£5 to Shetland Agricultural Society.—*Convener*, J. M. Goudie, Lerwick; *Secretary*, James J. Brown, Lerwick. Granted 1893. (In abeyance —no Show in 1914, 1915, or 1916.) (Grant in 1917.)

£3 to Orkney.—*Convener*, James Johnston, Orphir House, Orphir, Orkney; *Secretary*, D. B. Peace, jun., Auctioneer, Kirkwall. Granted 1883. (No Show in 1915 and 1916.) (Grant in 1917.)

£3 to Sanday, Orkney.—*Convener*, W. Cowper Ward, Scar House, Sanday, Orkney; *Secretary*, James Irvine, Stove Farm, Sanday, Orkney. Granted 1902. (In abeyance 1915 and 1916—no Show held.) (Grant in 1917.)

£3 to North Uist Agricultural Society.—*Convener*, Dr M. T. Mackenzie, J.P., Scolpaig, North Uist; *Secretary*, H. H. Mackenzie, J.P., Balelone, Lochmaddy. Granted in 1915 for 3 alternate years. (In abeyance 1915 and 1916—no Show held.) (Grant in 1917.)

£3 to East Mainland, Orkney.—*Convener*, John Clouston, Graemeshall, Holm, by Kirkwall; *Secretary*, Alexander Calder, Seabay, Tankerness. Granted 1898. (Grant in 1917.)

£3 to West Mainland, Orkney.—*Convener*, ; *Secretary*, George Learmonth, Pow, Quoyloo, by Stromness, Orkney. Granted 1900. (No Show 1916.) (Grant in 1917.)

Ross-shire Crofters' Show.—*Convener*, T. W. Cuthbert, Achindunie, Alness; *Secretary*, Robert Calder, Commercial Bank House, Alness. Granted 1910 for 3 alternate years, and 2 Silver Medals in the 2 intermediate years, which may be awarded to animals of any pure breed or cross. (In abeyance 1914, 1915, and 1916—no Show held.) Medals in 1917.

SPECIAL.

East of Fife Entire Horse Society.—*Convener*, Colonel A. Purvis of Kinaldy, Stravithie; *Secretary*, A. Brown, Pitcorthie Mains, Kilconquhar. 1 Large Silver Medal for 1917 and 1918.

GRANT IN ABEYANCE, 1917.

£3 to Rousay, Orkney.—*Convener*, John Logie, Trumland, Rousay, Orkney; *Secretary*, John Harrold, Springfield, Rousay. Granted 1903. (No Show 1915 or 1916.)

£3 to South Ronaldshay and Burray, Orkney.—*Convener*, Archibald Allan, St Margaret's Hope, Orkney; *Secretary*, George Esson, St Margaret's Hope, Orkney. Granted 1904.

£3 to Unst, Shetland.—*Convener*, Alexander M. Sandison, Moundeville, Uyasound, Shetland; *Secretary*, Thomas G. Hunter, Clivocast, Uyasound, Unst. Granted 1911 for 3 alternate years. (No Show 1914, 1915, 1916.)

MEDALS IN AID OF PREMIUMS GIVEN BY LOCAL SOCIETIES.

The Society, being anxious to co-operate with local Associations, will give a limited number of Silver Medals annually to Societies, not on the list of Cattle, Horse, or Sheep Premiums, in addition to the Money Premiums awarded in the Districts, for—

1. Best Bull, Cow, or Heifer of any pure breed included in Section 1.
2. Best Stallion, or Mare of any pure breed included in Section 1.
3. Best Tup, or Pen of Ewes of any pure breed included in Section 1.
4. Best Boar, Sow, or Breeding-Pig of any pure breed.
5. Best Pens of Poultry.
6. Best Sample of any variety of Wool.
7. Best Sample of any variety of Seeds.
8. Best managed Farm.
9. Best managed Green Crop.
10. Best managed Hay Crop.
11. Best managed Dairy.
12. Best Sweet-Milk Cheese.
13. Best Cured Butter.
14. Best Fresh Butter.
15. Best collection of Roots.
16. Best kept Fences.
17. Male Farm Servant who has been longest in the same service, and who has proved himself most efficient in his duties, and to have invariably treated the animals under his charge with kindness.
18. Female Servant in charge of Dairy and Poultry who has been longest in the same service, and who has proved herself most efficient in her duties, and to have invariably treated the animals under her charge with kindness.

19. Best Sheep-Shearer.
20. Most expert Hedge-Cutter.
21. Most expert Labourer at Draining.
22. Best Maker of Oat-Cakes.

It is left to the local Society to choose out of the foregoing list the classes for which the Medals are to be competed.

The Medals are granted for two years, and lapse if not awarded in those years.

No Society shall receive more than two Medals in any year.

Aberdeenshire.

1. Marnoch and Cornhill Agricultural Society.—*Convener*, James Andrew, Kinnairdy Castle, Bridge of Marnoch; *Secretary*, David Findlay, Bank Agent, Aberchirder. 2 Medals. 1914. (In abeyance 1914, 1915, and 1916—no Show held.)
2. New Deer Agricultural Society.—*Convener*, David M. Godsman, Mains of Fedderate, Maud; *Secretary*, P. Crighton, New Deer. 2 Medals. 1914. (In abeyance 1914 and 1916—no Show held.)
3. Vale of Alford Agricultural Association.—*Convener*, William A. Mitchell, Auchnagathle, Whitehouse, Aberdeen; *Secretary*, W. Alexander Ronald, East Cividley, Keig, Whitehouse. 2 Medals. 1915. (In abeyance 1915 and 1916—no Show held.)
4. Turriff Agricultural Association.—*Convener*, James Durno, Rothiebrisbane, Fyvie; *Secretary*, J. N. Ritchie, Turriff. 2 Medals. 1916.
5. Upper Donside Agricultural Association.—*Convener*, William A. Spark, Glenbuckat, Aberdeenshire; *Secretary*, Walter Beattie, Corbanchory, Cushnie, Alford. 2 Medals. 1916.

Argyllshire.

6. Mull and Morvern Agricultural Society.—*Convener*, J. H. Munro Mackenzie of Calgary, Mull; *Secretary*, Alexander J. Fraser, Clydesdale Bank, Tobermory. 2 Medals. 1913. (In abeyance 1914, 1915, and 1916—no Show held.)

Ayrshire.

7. Beith Farmers' Society.—*Convener*, David Kerr, Marshalland, Beith; *Secretary*, Matthew Gilmour, Clydesdale Bank, Beith. 2 Medals. 1916. (In abeyance 1916—no Show held.)

Banffshire.

8. Northern Seeds and Roots Association.—*Convener*, George Smith, Ordens, Boyndie, Banff; *Secretary*, James Young, 28 Seafield Street, Portsoy. 2 Medals. 1914. (In abeyance 1915 and 1916—no Show held.)
9. Aberdour and North-East Agricultural Society.—*Convener*, Alexander Beddie, Bridgend, Fraserburgh; *Secretary*, Robert Pittendrigh, jun., Newseat, Fraserburgh. 2 Medals. 1915. (In abeyance 1915 and 1916—no Show held.)

Caithness.

10. Caithness Agricultural Society.—*Convener*, D. P. Henderson of Stemster, Halkirk; *Secretary*, George Harrold, Accountant, Wick. 2 Medals. 1914. (In abeyance 1915 and 1916—no Show held.)

Dumfriesshire.

11. Sanquhar Farmers' Society.—*Convener*, James Moffat, Gateside, Sanquhar; *Secretary*, W. M. Henderson, Solicitor, Sanquhar. 2 Medals. 1914. (In abeyance 1914, 1915, and 1916—no Show held.)

Fifeshire.

12. Fife Agricultural Society.—*Convener*, David Ferrie, Parbroath, Cupar; *Secretary*, F. W. Christie, Eden View, Cupar-Fife. 2 Medals. 1914. (In abeyance 1915 and 1916—no Show held)

Lanarkshire.

13. Shotts Calderwater Farmers' Society.—*Convener*, John Weir, Shottsburn, Holytown; *Secretary*, Alexander Waddell, 49 Wesleyan Street, Glasgow. 2 Medals. 1916. (In abeyance 1916—no Show held.)

Orkney.

14. Shapansey Agricultural Association.—*Convener*, James Johnston of Coubister, Orphir House, Orphir, Orkney; *Secretary*, William Robertson, Elwickbank, Shapansey, Orkney. 2 Medals. 1915. (In abeyance 1915 and 1916—no Show held.)

Perthshire.

15. Moulin Agricultural Association.—*Convener and Secretary*, Robert M'Gillewie, Dunkeld. 2 Medals. 1913. (In abeyance 1914, 1915, and 1916—no Show held.)
16. Dunblane Agricultural Society.—*Convener*, A. H. Anderson, J.P., Kippendavie Estate Office, The Firs, Dunblane; *Secretary*, John Stewart, Solicitor, Dunblane. 2 Medals. 1916. (In abeyance 1916—no Show held.)

Stirlingshire.

17. Denny and Dunipace Agricultural Association.—*Convener*, William Chapman, Bank of Scotland, Denny; *Secretary*, Alexander Henry, Solicitor, 30 Glasgow Road, Denny. 2 Medals. 1915. (In abeyance 1916—no Show held.)

Applications from other Districts must be lodged with the Secretary of the Society *by 1st November next.*

RULES OF COMPETITION.

1. All Competitions must be at the instance of a local Society.
2. The classes for which Medals are granted must be in accordance with the list at page 53. The Committee shall select the classes, and specify them in the Report.
3. A Committee of Management shall be appointed, and the Convener of the Committee must be a Member of the Highland and Agricultural Society.
4. The Money Premiums given in the District must be not less than £2 for each Medal claimed.
5. The Medal for Sheep-Shearing shall always accompany the highest Money Premium.
6. There must not be fewer than three competitors in all the classes.
7. Regarding Reports, despatch of Medals, and application for renewal of Grant, Rules 10 and 11, Section I., will apply.
8. When a grant of Medals has expired, the District cannot apply again for Medals for two years.

PLOUGHING COMPETITIONS.

The Minor Silver Medal will be given to the winner of the first Premium at Ploughing Competitions, provided a Report in the following terms on the official form is made to the Secretary, within one month of the Competition, by a Member of the Society. Forms of Report to be had on application.

FORM OF REPORT.

I, of , Member of the Highland and Agricultural Society, hereby certify that I attended the Ploughing Match of the Association at in the county of on the when ploughs competed; of land were assigned to each, and hours were allowed for the execution of the work. The sum of £ was awarded in the following proportions, viz. :—

[*Here enumerate the names and designations of successful Competitors.*]

RULES OF COMPETITION.

1. All Matches must be at the instance of a local Society or Ploughing Association, and no Match at the instance of an individual, or confined to the tenants of one estate, will be recognised.
2. The title of such Society or Association, together with the name and address of its Secretary, must be registered with the Secretary of the Highland and Agricultural Society, 3 George IV. Bridge, Edinburgh.
3. Not more than one Match in the same season can take place within the bounds of the same Society or Association.
4. All reports must be lodged within one month of the date of the Match, and certified by a Member of the Highland and Agricultural Society who was present at it.
5. A Member can only report one Match; and a Ploughman cannot carry more than three Medals in the same season.
6. To warrant the grant of the Medal there must have been twelve ploughs in Competition, and not less than Three Pounds awarded in Prizes by the local Society. The Medal to be given to the winner of the first prize.
7. The Local Committee or Society may, if they desire, arrange to let each ploughman have one person to guide the horses for the first two and the last two furrows, but in no case shall ploughmen receive any other assistance, and their work must not be set up nor touched by others. Attention should be given to the firmness and sufficiency of the work below more than to its neatness above the surface.
8. The Local Committee is required to fix the time to be allowed for ploughing the portion of land, and they are recommended that the time be at the rate of not more than ten hours per imperial acre on light land, and fourteen hours on heavy or stony land.

HOEING COMPETITIONS.

The Minor Silver Medal will be given to the winner of the first Premium at Hoeing Competitions, provided a Report in the following terms on the official form is made to the Secretary within a month of the Competition by a Member of the Society. Forms of Report to be had on application.

RULES OF COMPETITION.

1. All Matches must be at the instance of a local Society or Hoeing Association, and no Match at the instance of an individual, or confined to the tenants of one estate, will be recognised.

2. The title of such Society or Association, together with the name and address of its Secretary, must be registered with the Secretary of the Highland and Agricultural Society, No. 3 George IV. Bridge, Edinburgh.

3. Not more than one match in the same season can take place within the bounds of the same Society or Association.

4. All reports must be lodged within one month of the date of the Match, and certified by a Member of the Highland and Agricultural Society who was present at it.

5. A Member can only report one Match; and same Competitor cannot carry more than three Medals in the same season.

6. To warrant the grant of the Medal there must have been twelve hoes in Competition, and not less than Three Pounds awarded in prizes by the local Society. The Medal to be given to the winner of the first prize.

7. The time to be allowed to be decided by the local Committee, but in no case to exceed two hours for two drills of 100 yards each, the third drill being unoccupied, so that Competitors do not interfere with their neighbour's work.

8. Competitors must finish their work as they go along—no turning back or after-dressing allowed. Handpicking or transplanting shall be strictly prohibited.

9. A Committee shall be appointed to watch the work, and any Competitor found transplanting or otherwise not complying with the Rules shall have his number withdrawn, and be debarred from receiving any prize which might otherwise have been awarded to him.

NOTE.—Medals will be awarded under similar conditions for Competitions in hand-singling.

LONG SERVICE CERTIFICATES AND MEDALS.

Certificates and Medals for long service are awarded by the Society to farm servants, male or female, having an approved service of not less than thirty years—(*a*) with one employer on the same or different holdings; (*b*) on the same holding with different employers. These Certificates and Medals will be issued as applications are received.

Forms to be obtained from the Secretary.

CLASS III.

COTTAGES AND GARDENS.

The following Premiums are offered for Competition in the Parishes after mentioned.

The Premiums are granted for two years.

PREMIUMS FOR BEST KEPT COTTAGES AND GARDENS.

1.	Best kept Cottage	£1 0 0
	Second best	0 10 0
2.	Best kept Cottage Garden	1 0 0
	Second best	0 10 0

RULES OF COMPETITION.

1. Competitions may take place in the different parishes for Cottages and Gardens, or for either separately.

2. The occupiers of Lodges at Gentlemen's Approach Gates and Gardeners' Houses are excluded, as well as others whom the Committee consider, from their position, not to be entitled to compete. The inspection must be completed by the 1st of October. In making the inspection, the Conveners may take the assistance of any competent judges.

3. It is left to the Committee of the District to regulate the maximum annual rent of the Cottages, which may, with the garden, be from £5 to £7.

4. To warrant the award of full Premiums, there must not be fewer than three competitors in each class. If there are less than three competitors in each class, only half Premium will be awarded.

5. A person who has gained the highest Premium cannot compete again.

6. If the Cottage is occupied by the proprietor, the roof must be in good repair; if the roof is thatch, it must be in good repair, though in the occupation of a tenant. The interior and external conveniences must be clean and orderly; the windows must be free of broken glass, clean, and affording the means of ventilation. Dunghills, and all other nuisances, must be removed from the front and gables. In awarding the Cottage Premiums, preference will be given to Competitors who, in addition to the above requisites, have displayed the greatest taste in ornamenting the exterior of their houses, and the ground in front and at the gables.

7. In estimating the claims for the Garden Premiums, the judges should have in view—the sufficiency and neatness of the fences and walks; the cleanness of the ground; the quality and choice of the crops; and the general productiveness of the garden.

8. Reports, stating the number of Competitors, the names of successful parties, and the nature of the exertions which have been made by them, must be lodged with the Secretary of the Highland and Agricultural Society *on or before the* 1*st November next.*

9. When a grant of Money has expired, the District cannot apply again for aid for four years.

Parishes desirous of these Premiums must lodge applications with the Secretary *on or before the* 1*st November next.*

(*No Money Grants offered in* 1917.)

MEDALS FOR COTTAGES AND GARDENS, OR GARDEN PRODUCE, POULTRY, AND BEE-KEEPING.

1. The Society will give annually one or two Minor Silver Medals to a limited number of local Associations or individuals, who establish Competitions and Premiums for Cottages, Gardens, Garden Produce, or Bee-Keeping. The Medals will be granted for two years.

2. The Medals may be offered in any two of the following sections, *but under no circumstances will the two Medals be given in one of the sections:—*

(1) Best kept Cottage or best kept Cottage and Garden. (One Medal only.)

(2) Best kept Garden. (One Medal only.)

(3) Best Collection of Garden Produce—Flowers excluded. (One Medal only.)

(4) Best Pen of Poultry.

(5) Honey. (One Medal only.)

3. The annual value of each Cottage, with the ground occupied in the parish by a Competitor, must not exceed £15. The occupiers of Lodges

at Gentlemen's Approach Gates, and Gardeners in the employment of others, are not entitled to compete.

4. If Competition takes place for Garden Produce, such produce must be *bona fide* grown in the Exhibitor's Garden. He will not be allowed to make up a collection from any other Garden. The produce must consist of Vegetables, or Vegetables and Fruit (not Fruit alone). Flowers are excluded.

5. The Honey must be the produce of the Exhibitor's own Hives.

6. To warrant the award of a Medal, there must not be fewer than three Competitors.

7. Blank forms for Reports of Competitions will be furnished to the Secretaries of the different Districts. These must, in all details, be completed and lodged with the Secretary of the Highland and Agricultural Society as soon as possible after the Show, and in no case later than *1st November*, for the approval of the Directors, against whose decisions there shall be no appeal.

8. When a grant of Medals has expired, the District cannot apply again for aid for two years, and if no competition takes place in a District for two years the grant expires.

9. Applications for these Medals must be made *before 1st November next.*

Aberdeenshire.

1. CRUDEN HORTICULTURAL SOCIETY.—*Convener*, Robert Brand, Ardiffery, Hatton, R.S.O., Aberdeen; *Secretary*, John Robb, Hatton, R.S.O., Aberdeen. 2 Medals. 1913. (In abeyance 1914, 1915, and 1916—no Show held.)
2. KINELLAR HORTICULTURAL AND POULTRY SHOW.—*Convener*, W. S. Cantlay, Glasgoego Cottage, Kinellar; *Secretary*, Neil Smith, Kinellar. 2 Medals. 1914. (In abeyance 1915 and 1916—no Show held.)

Fifeshire.

3. NEWBURGH GARDENING SOCIETY.—*Convener*, Andrew Kay, Hillside Cottage, Newburgh; *Secretary*, David M. Adamson, High Street, Newburgh. 2 Medals. 1916. (In abeyance 1916—no Show held.)

Perthshire.

4. BRACO HORTICULTURAL SOCIETY.—*Convener*, John W. Stirling, J.P., Braco; *Secretary*, William M'Ildowie, Crofthead, Braco. 2 Medals. 1915. (In abeyance 1915 and 1916—no Show held.)

Renfrewshire.

5. INVERKIP, WEMYSS BAY, AND SKELMORLIE HORTICULTURAL SOCIETY. —*Convener and Secretary*, Robert H. Hamilton, Clydesdale Bank, Skelmorlie. 2 Medals. 1914. (In abeyance 1915 and 1916—no Show held.)
6. "SIR JOHN STIRLING MAXWELL" GARDENS HORTICULTURAL SOCIETY.—*Convener*, J. Campbell Murray, Hagg's Castle, Pollokshields; *Secretary*, John R. Bain, 7 Holmhead Crescent, Cathcart. 2 Medals. 1916.

ANNUAL SHOW, 1917

At the Anniversary General Meeting of Members on 10th January 1917 it was reported that the Directors had decided, on the unanimous recommendation of the Shows Committee, not to proceed with arrangements for the holding of a Show in 1917.

In submitting this Report the Convener of the Shows Committee, Major Scott Plummer, stated that the Committee had carefully considered the possibility of holding a General Show, and also, as an alternative proposal, the holding of a Show of Stock only. The Committee recognised that the situation which existed in 1916 with regard to implements and railway facilities would in all probability exist in an intensified form in July 1917. They especially had regard to the urgent recommendation of the Board of Trade that all travelling not absolutely necessary should be avoided. It was further considered that the representations made by farmers as to the shortage of labour necessary for food production would be seriously prejudiced by diverting to other purposes the considerable amount of labour involved in holding a Show and in preparing stock for exhibition.

INDEX